Journal of the Society of Arts.

FRIDAY, MAY 16, 1856.

TWENTY-SECOND ORDINARY MEETING.

Wednesday, May 14, 1856.

The Twenty-second Ordinary Meeting of the One Hundred and Second Session was held on Wednesday, the 14th inst., John Simon Esq., F.R.S., Medical Officer to the General Board of Health, in the Chair.

The following Candidates were balloted for, and duly elected Ordinary Members:—

Christian, Robert.	Thomson, Adam.
Maxwell, Sir William, Bart.	Woodhouse, John Thomas.
Rough, Robert.	

The paper read was—

ON MEANS AVAILABLE TO THE METROPOLIS AND OTHER PLACES, FOR THE SUPPLY OF WATER FREE FROM HARDNESS, AND FROM ORGANIC IMPURITY.

By Professor Clark, M.D., of Marischal College and University, Aberdeen.

Pure water, that is, water apart from all other matter, is hardly to be found in nature. Rain water is only one approximate to pure water; distilled water is but another; melted bright ice is perhaps a nearer approximate; but were we to repeat the operations of distillation, or of freezing water and then melting the ice, we would obtain water that for all practical purposes is pure.

Now, let us attend for a little to what will take place when solid matter is brought into contact with pure water; first, in a case where the solid is insoluble—say, a stone. The water and the stone produce no effect on each other, further than that the stone, being bulk for bulk heavier than the water, will sink to the bottom. If, again, we break up the stone and bruise it into powder, still the powder will sink to the bottom, but now more slowly, in proportion as the powder has been ground fine, the rougher grains of the powder falling first; but very fine powder may be hours, and even days, of subsiding, so as to leave the water clear. The temporary suspension of the fine powder in the water, and the final subsidence of it, are alike *mechanical* operations. The powder was for a time suspended in the water, much as dust may for a time be suspended in the air, and on repose fall down again; the coarser particles first, the finer last, but finally all down, quite unaltered in its properties.

Now, as it is by *mechanical* means that the insoluble solid is kept for a time suspended in the liquid, so it is by mechanical means that they are separable. Subsidence is only one of those means; filtration is another. The solid is arrested on the surface, or not far below the surface of the filter, by means as mechanical as a sieve.

Without engaging at present in any discussion about the process of filtration, this much I may state by way of indicating one limit that restricts the usefulness of this process, that many rocks, when ground into very fine powder, and much soaked in water, acquire an adhesive consistence—that is, become of the nature of clay. Solid matter of such consistence readily diffuses in water, and, for all practical purposes, is incapable of being satisfactorily separated, either by subsidence or by filtration. Accordingly, it often happens that river water is very imperfectly cleared by filtration, after such rains as wash into it the finer particles from the surface of roads and fields.

But, next, if the solid brought into contact with pure water be soluble, instead of insoluble, a very different result will be obtained. Let us, for instance, drop into one glass of water a little salt, and into another a little sugar, and stir about; the salt and the sugar will disappear; the taste will denote a different change in each glass of water. What was before, in each glass, a solid and a liquid, will now be all a liquid. We call the results, not mixtures, but solutions. The change is not mechanical, it is chemical. No longer will the solid sink to the bottom on repose; no longer will the solid be separable from the liquid by filtration. On the contrary, the solution may itself be mixed with solid matter, and be separated from it by means of subsidence or filtration, and be then found precisely the same solution it was before.

You can easily understand now that spring water, which seldom contains any solid matter in a state of mixture, is generally a specimen of water with solid matter in it in a state of solution; for spring water always has in solution more or less of solid matter; very commonly between 1 to 1,000 and 1 to 20,000 of water; sometimes even 2 or more to 1,000. But while spring water is an instance of water with solid matter in it in solution, river water often affords instances of water with solid matter in it, both in a state of solution and in a state of mixture.

Thus far we have been considering water as it acts on solids, mechanically or chemically; as a lifeless liquid acts on a lifeless solid. I am going now to do little more than mention a case where vegetable and animal life come into play. It is not so in all waters, but in a great majority of those in and around London this happens: that free as the waters may be from any mixed solid matter—and they generally are so when pumped up from wells fed by springs—vegetation on the surface of the water, and on the sides and bottom of reservoirs, will appear spontaneously, as it were, after a certain exposure of the water to light and air. This vegetation soon comes to be accompanied with animalcules and various organic objects in great numbers; and in process of time the vegetation and the animalcules, which have their period of growth, come to have also their period of decay, and to be a great source of contamination to those waters.

Returning again for a little to solid matter in solution, let us advert to the nature of such solid matter, in the view of explaining the cause of that quality of water called hardness.

The great bulk then of the solid matter held in solution in ordinary waters, consists of salts; that is, combinations of acids with various bases. The acids are chiefly:—Carbonic acid, producing carbonates; sulphuric acid, producing sulphates; nitric acid, producing nitrates; and hydro-chloric acid, producing chlorides.

The saline bases are chiefly:—Soda; potash, less frequently; ammonia, in small quantities and rarely; lime; magnesia.

For the present, it is neither those acids apart from the bases, nor these bases apart from the acids, that we have to do with; but the acids and bases combined in the form of salts, whereby the peculiar characters of their components are neutralised.

Now, in this neutral state, we need give ourselves little trouble as regards the acids; for I found on trial that the hardness of a water is quite unaffected by any one of the before-named acids being substituted for another. Then as to the before-named bases, the only ones that affected the hardness of water, I found to be lime and magnesia. These two bases are the sole hardeners of ordinary waters; lime the chief. When magnesia occurs along with lime, as is very common, this base is the great *curdler* of soap. A lime salt by itself in water, a magnesia salt by itself in water—either of these is a destroyer of soap; but mag-

nesia along with lime is often a great curdler of soap, without otherwise being a destroyer of it.

This explanation of the cause of hardness will prepare you for entering on the subject that it is my duty to explain to you to-night. In most waters around the metropolis, whether found in rivers or in wells, it is chalk that is the chief cause of their hardness. Now, this chalk may be removed from the water by a very simple and inexpensive process that I proposed fifteen years ago, that has been in successful operation on a large scale in waterworks near Woolwich, for a year and a half past, and that may at any time be brought into operation on a scale more than adequate for the supply of this great metropolis. In such abundance is this hardening matter present, that the process alluded to can separate a ton of chalk from every million of gallons of the purest accessible spring waters. The average supply of a single family would yield up 100 lbs. of chalk in eight months, or a pound and a quarter every three days. So great is the effect of the invention in softening, that whereas the hardening matter of 100 gallons of spring water from wells or borings sunk in the chalk strata will destroy 35 oz. of soap, the hardening matter remaining in 100 gallons of the same water, after being softened, will destroy only 5 oz. The process removes from such water 85 per cent. of the hardening matter.

In order to explain how the invention operates, it will be necessary to glance at the chemical composition and some of the chemical properties of chalk; for while chalk makes up the great bulk of the matter to be separated, chalk also contains the ingredient that brings about the separation. The invention is a chemical one for expelling chalk by chalk.

Chalk then consists, for every 1lb. of 16oz., of

Lime	9oz.
Carbonic acid............	7oz.

The 9oz. of lime may be obtained apart, by burning the chalk, as in a lime kiln. The 9oz. of burnt lime may be dissolved in any quantity of water, not less than 40 gallons. The solution would be called lime water. During the burning of the chalk to convert it into lime, the 7oz. of carbonic acid are driven off. This acid when uncombined, is naturally volatile and mild; it is the same substance that forms what has been called soda water, when dissolved in water under pressure.

Now so very sparingly soluble in water is chalk by itself, that, probably, upwards of 5,000 gallons would be necessary to dissolve 1lb. of 16oz.; but by combining 1lb. of chalk in water with 7oz. additional of carbonic acid, (that is to say, as much more carbonic acid as the chalk itself contains,) the chalk becomes readily soluble in water, and when so dissolved, is called bicarbonate of lime. If the quantity of water containing the 1lb. of chalk with 7oz. additional of carbonic acid were 400 gallons, the solution would be a water of the same hardness as well water from the chalk strata, and not sensibly different in other respects.

Thus it appears that 1lb. of chalk, scarcely soluble at all in water, may be rendered soluble in it by either of two distinct chemical changes—soluble by being deprived entirely of its carbonic acid, when it was capable of changing water into lime water, and soluble by combining with a second dose of carbonic acid, making up bicarbonate of lime.

Now if a solution of the 9oz. of burnt lime, forming lime water, and another solution of the 1lb. of chalk and the 7oz. of carbonic acid, forming bicarbonate of lime, be mixed together, they will so act upon each other as to restore the 2lb. of chalk, which will, after the mixture, subside, leaving a bright water above. This water will be free from bicarbonate of lime, free from burnt lime, and free from chalk, except a very little which we keep out of account at present for the sake of simplicity in this explanation. The following table will show what occurs when this mutual action takes place:—

Agents.			Products.	
Bicarbonate of lime in 400 gallons ...	Chalk......... with	16oz.	= 16oz. of chalk.	=2lb.
	Carbonic acid	7oz.	=16oz. of chalk.	
Burnt lime in 40 gallons of lime water		9oz.		

But, instead of the whole chalk being separable by the process from the water, only 10-11ths would be separated; so that, with regard to chalk, the accurate result would be expressed, if we suppose 440 gallons of similar water to be operated upon, containing 17½oz. of chalk. There would be separated, 16oz.;—there would remain in solution, 1½oz. Or, to express the result with reference to a single gallon, each gallon would contain of chalk, if unsoftened, 17½ grains; if softened, 1½ grains; and would deposit 16 grains.

Here is a convenient place to explain a mode of expressing hardness, in very general use now, but first invented by me, in connection with certain new chemical tests of water, in order to work out conveniently the softening process that has been described.

Each degree of hardness is as much hardness as a grain of chalk, or the lime, or the calcium, in a grain of chalk, would produce in a gallon of water, by whatever means it may be dissolved.

Thus, our supposed water would be 17½ degrees of hardness before softening; 1½ degrees after softening. And this would be the real result, supposing there were in the water no other hardening matter but chalk; but in the best quality of chalk water from springs or wells in the chalk strata around the metropolis, there is actually present a small proportion of other hardening matter, such as to prevent the water from being softened lower than 2½ degrees. A gallon of such water, after being evaporated, was found to have held in solution of solid matter—

	Grains.
Before softening	23
After	7
The difference	16

was due to chalk removed by the softening process.

These explanations will make it easy to comprehend the sucessive parts of the softening process.

Supposing it was a moderate quantity of well water from the chalk strata around the metropolis that we had to soften, say 400 gallons. This quantity, as has already been explained, would contain 1lb. of chalk, and would fill a vessel 4 feet square by 4 feet deep.

We would take 9oz. of burnt lime, made from soft upper chalk; we first slack it into a hydrate, by adding a little water. When this is done we would put the slacked lime into the vessel where we intend to soften; then gradually add some of the water in order to form lime water. For this purpose, at least 40 gallons are necessary, but we may add water gradually till we have added thrice as much as this; afterwards, we may add the water more freely, taking care to mix intimately the water and the lime water, or lime. Or we might previously form saturated lime water, which is very easy to form, and then make use of this lime water, instead of lime, putting in the lime water first, and adding the water to be softened. The proportion in this case would be one bulk of lime water to ten bulks of the hard water.

I call your attention to one circumstance in the arrangement just described—that the lime, or softening ingredient, is put into the vessel *first*. Hence there will be an excess of lime, always causing to be present in the mixture, so long as the process is going on, more of lime than is necessary for effecting the precipitation of the chalk present in the water. The expediency of thus keeping up an excess of lime till we come to the end of the process arises from this important practical fact, that the chalk (or carbonate of lime) produced in the process is far more easy to precipitate where there is lime water in excess. Another remarkable fact is, that the carbonate of lime

thus precipitated forms, not into a powder, but into crystals, distinct enough to be seen in sunshine. But what you will wish to know now is, by what mark is the conductor of the process to find out when there is enough of water to take up the last of the excess of lime, so as to be enough but no more.

This is done by what has been called the silver test; the only test necessary to the operator after the process is fairly set agoing. This test is a solution of nitrate of silver in twice-distilled water, in the proportion of an ounce per pint. In making use of the silver test with ordinary waters, we get a white precipitate; but if the water have in it a notable excess of lime water, there is a light reddish brown precipitate produced; but if the excess be very slight, we get only a feeble *yellow* precipitate. The way we make use of the test is to let two or three drops of it fall on the bottom of a white tea-cup; then add the water somewhat slowly; then if there be the slightest excess of lime, a yellow colour will show itself, though it will sometimes disappear again on adding more water. In practice, we may even leave the mixture when it affords a barely perceptible trace of this yellowness; for on the waters being exposed to the air for a night, a very slight remaining excess of lime will probably no longer be indicated when the test is applied next morning. The carbonic acid of the atmosphere suffices to destroy a very slight excess of lime.

Other tests than the silver test were invented by me in order to make it easy, in an approximate way, to ascertain how much lime should be provided for softening a given quantity of any water submitted to those tests. It would be out of place here to enter on an explanation of them; but when the lime has been adjusted to the water in suitable proportions by means of those other tests, it is by the silver test that we make the final adjustment; and *with such accuracy may this adjustment be made, that a given water may be softened on several successive occasions, and on any scale between a pint and millions of gallons, without the softened water ever exceeding its minimum possible hardness more than 1-10th of one degree of hardness.* Repose will finish the process. Over the subsided chalk there will be a clear soft water, fit for immediate use.

The softened water thus obtained has no action on lead pipes or cisterns, as many soft waters have.

While the results here given represent accurately the change in hardness produced by the invention on the most abundant and best well water from the chalk strata around London, there are, in particular localities, wells with inferior water, which, although greatly benefited by the application of the process, cannot be made so soft as has been described. Thus, in Plumstead Water Works, for supplying Plumstead, Woolwich, and Charlton, with well water softened by the invention, the hardness of the water I found to be about 21½ degrees when pumped up, and about 8½ when softened, but still it is true of this softened water, that all the hardness in it remaining from chalk does not exceed 1½ degrees, the same as in the choicest chalk spring water. The other 7 degrees of hardness are due to other hardening matter than chalk.

The softening process may be advantageously applied in many places to spring water derived from the new red sand-stone formation.

In the natural course of discussion, I should now enter on an explanation of the works at Plumstead, in the neighbourhood of Woolwich, where the softening process has been in successful operation for the last year-and-a half. Addressing you in the presence of the engineer who has planned those works with much skill and success, I feel how much more advantageous it will be to you, and how much more agreeable it is to myself, to refer you for this explanation to Mr. Homersham. The process is of a nature to require a larger scale of operation than any other heretofore practised within the circle of chemical manufactures. With such a process to put into operation for the first time, there was no small difficulty in making a fitting choice of devices, and means to insure the successful and undisturbed application of the process, and so very successful was the application in this instance, that the works have continued in operation till now without any material alteration, and continue to be a fitting model for works on a much larger scale.

Experience at the Plumstead water works has proved that in the working of the softening process a settling reservoir may be filled up with water and its mixture of precipitated chalk, may be left to subside, and may be pumped out for use daily, and that the softening process may go on for months without its being necessary to remove the precipitated chalk. A ton of pure burnt lime will produce 3¼ tons of this precipitate, which forms a very superior kind of commercial whiting. Unfortunately I am not in a position to state from experience what is the commercial value of it as whiting, because the water company, for reasons unknown to me, have heretofore declined, or delayed to provide means for collecting the precipitated carbonate unmixed with gritty matter; but according to the best information I have been able to obtain, the burnt lime and the whiting produced are weight for weight nearly of the same commercial value; that is to say, about £1 per ton, so that £1's worth of burnt lime will produce £3 10s. worth of whiting. According to this estimate, it is probable that the process will, when worked with due care, come nearly to pay its own expenses, including the interest of capital expended in such erections as the softening process makes necessary.

Farther than removing chalk, the process has not been observed to operate with any marked effect, so far as the *mineral* matter in solution is concerned. The removal of the chalk is attended with several advantages.

1st. The water is much softened, and there is a considerable saving in soap, as has already been stated. There is besides, in washing, a still more considerable saving in the wear and tear of clothes. Soda, which is sometimes added to hard waters for the purpose of softening them, produces a yellowness, more especially in flannels, and is injurious to certain dyes.

2nd. Soft water is much more pleasant to wash in and to bathe in, and the hands are less apt to be chapped. Soft water also is notoriously better for making tea, and cooks more readily such articles as rice or peas.

3rd. Owing to the previous removal of chalk, there is no powder or incrustation from the softened water on boiling, as is the case with unsoftened chalk water. Dirty clothes are apt to have dirt fastened in them by this deposit, when the clothes are steeped in warm water. It is probably the absence of this deposit from softened water that leads the laundresses to say that they can produce their linens much purer by the softened water than by the unsoftened.

Among chemical processes the one that we employ for softening chalk waters is remarkable for this, that it merely removes certain matter from waters without substituting any other matters in its place. Most chemical processes, when they produce a precipitate from water, leave in solution matter of another kind in its place. Accordingly, 7,000 gallons of chalk spring water, which contain 23lbs. of solid matter in solution, whereof 16lbs. fall down in the form of chalk, retain in solution only the remaining 7lbs.

So far, then, as regards the mineral matter, the change effected by the softening process consists in the removal of most of the chalk that the water contains. Let us now proceed to consider what effects the softening process produces, as respects organic matter.

Since in general the wholesomeness of a water is much more affected by the presence of organic matter than by the presence of mineral matter, freedom from organic matter is of still more importance than freedom from hardening matter. It seems a fact well established by observation, that some of the poisons producing epidemic disease find a congenial *habitat* in waters contaminated with organic matter.

Now, chalk water may be contaminated by organic

matter, either first, from without, or second, from within.

1st. *From without;* as in a river, by surface drainage, or land drainage, or even by the sewage of houses and towns.

In the case of a water thus contaminated, a considerable proportion of the contaminated matter is incorporated with the precipitated chalk, and is removed with it. This fact appears on double evidence. On the one hand, the chalk precipitated from contaminated water is much more coloured than chalk precipitated from a pure solution of bicarbonate of lime, and when scorched in a clean glass tube gives off an offensive smell not recognisable when the chalk is pure; on the other hand, the softened water is much freer from colour than the unsoftened.

2nd. *From within.* When chalk spring water is pumped up from a well and exposed to light and air in a clean glass vessel, capable of holding a few gallons, with a glass covering, and so exposed that we can observe the changes as they take place from day to day, it will be seen that all around the sides and bottom a green vegetation will appear in summer time within a few days. In process of time this vegetation tends to a brown, and if a close observation be made, a slight incrustation may be discovered, partly to float on the surface of the water, and partly to adhere to the sides and bottom of the vessel. This incrustation consists of chalk slowly precipitated from the water by the decomposition of the duplicate dose of carbonic acid that kept the chalk dissolved. The decomposed carbonic acid affords carbon (charcoal) to the plants, and the chalk that was kept in solution by it forms the mineral part of the incrustation. If the glass vessel, after having been exposed as described for several weeks, be emptied, a dirty-like brownish incrustation may be very well seen, including vegetable matter, all down the sides and on the bottom. This brownish incrustation has a strong, offensive, marshy smell. If side by side with the spring water there be exposed, in a similar glass vessel, the same water, only previously softened, the softened water will continue for weeks and months unaltered, all the while that the unsoftened water is becoming more and more contaminated from within.

The vegetation that is here represented truly as having been observed in a glass vessel in a few days, begins in practice, on the large scale, as soon as chalk spring waters enter into light. On looking down a wide cast-iron pipe of many feet in depth, employed as a channel for a copious spring to rise perpendicularly to the surface of the ground, there may be seen on the inside of the pipe, so far as light will permit the observer to see down, a brown hair-like vegetation of the offensive character already described. Where a chalk spring feeds a stream in an earthy channel, specimens of this offensively smelling vegetation may be found within a few yards of the spring.

Eight months after the Plumstead Water Company had been carrying on the softening process with success, and much to the satisfaction of the consumers, it occurred to the Company to try how far the consumers would continue to be satisfied with the water, if the softening process were omitted. The experiment was, of course, made without any advice of mine, and even without my knowledge, but I feel very much obliged to the Company for having made it. The account that I obtained of the result was received by me from a friend who visited the works on the eleventh and twelfth days after the addition of lime to the water had been omitted. My friend, who had visited the works repeatedly, but had never witnessed a trace of vegetation on the surface of the waters in the softened state, and who had not heard of the change, had more than one sense taken by surprise. On entering within the boundary, but roofless, walls that surround the reservoirs (it was on the afternoon of a calm, hot July day), he was saluted with a stench of decaying vegetable matter, and beheld the surface of the unsoftened water (which was now daily supplied to the reservoirs, and daily removed for use) all covered with masses of vegetable matter (*confervæ*), to such an extent as, he wrote me at the time, scarce could a square inch of the surface be observed uncovered. No microscopic observations of the water were made at the time. If they had been made, I have no doubt that animalcules would then have been found as abundantly as they may now be found in the water of any company that now supplies the metropolis; though, of course, without any of those peculiar organic objects that are introduced by means of drainage and sewage. Not slow were the consumers in discovering the sudden hardness that had come over the water, nor were they silent under the discovery, and the company gave up their instructive experiment at the end of three weeks.

As to the sources available for the supply of water to the metropolis, they have more especially of late years been so much discussed, that they may be specified and dismissed in a few words.

In regard to the water of the Thames, so far as it is under the influence of tides, we have come, however tardily, to the conclusion that water such as has, however well or however ill, performed its duty in the sewers of the metropolis, is not again fit or even seemly for the use of the inhabitants of the metropolis. So far as the matter of sewage continues to be admitted to be a proper element of water fit for domestic use, it is no longer the sewage of the metropolis, but the sewage of the many towns draining into the Thames above Teddington Lock, that is recognised by the indifference of the public and the wisdom of Parliament, as of this harmless quality. It is an old maxim, and a true one, that there is no disputing about tastes. Upon some subjects, he that increaseth knowledge increaseth sorrow; so I refrain from adding any observations to disturb the satisfaction of such as deem the contents of sewers to be rather a good thing in water, whether the sewers be in town or country. But passing from this, who shall prevent the contamination that rivers are subject to, from time to time, by the fall of heavy rains? Experience has taught us that filtering will not arrest or prevent the presence of numerous animalcules, many of them visible to the naked eye, in the filtered water of the Thames, whether supplied from above or below Teddington Lock. Indeed, such is the sluggish motion and stagnant state of the Thames above Teddington Lock, that I doubt whether the water supplied from thence will not be more loaded with organic matter than it would be if the supply were taken within a mile or two below that Lock. It is no uncommon thing for the microscope to discover minute insects in the filtered Thames water; not twenty per each half-gallon, but twenty different species. Then, apart from the organic contamination that mere filtration will never separate from the Thames water, and which would never be found at all in the softened water that I have been describing, there is the disadvantage of hardness, which is five times greater in the Thames than it would be in the softened water.

And what shall we say, in the middle of the nineteenth century, of the treatment that spring water receives, in order to prepare it for the domestic use of the metropolis? Two hundred and fifty years ago, Sir Hugh Myddleton bethought him of making a canal to lead spring water as direct as he could into London, and his canal is known to this day as the New River. I have already explained to you that chalk spring water (which this was) acquires contamination by simple exposure to light and air. Sir Hugh Myddleton, or the known resources of his time, could not avail to hinder this. But with all our known resources, it seems that a wealthy company, like the New River, can do no better for us yet than dilute their five million gallons of daily supply of spring water with somewhere about double its own bulk of contaminated water from the river Lea, leading the mixture to London by a channel that has been made indeed recently somewhat straighter than Sir Hugh's; and when the spring water has kept company long enough with the dirty Lea, the New River

Company pretends to get rid by filtrationof the contamination thus inevitably acquired by spring water.

As to the deep wells in and around London, it were needless to say much, for it is notorious that the supply from that source is already overtaken by the numerous wells that have been sunk for the supply of breweries and other manufactories.

As to the project that came out, some years ago, from the General Board of Health, in the first years of its existence, I could perhaps speak somewhat advisedly, for I have gone over a good part of the ground, have collected specimens of the various waters, and have examined them chemically, and I am aware of microscopic examinations that have been made of the same specimens, by competent friends of mine, but the project is a dead project, and according to the maxim, that we should speak nothing but what is good of the dead, humanity dictates that we should say nothing at all of this project.

As to the sufficiency of the chalk strata for the supply of the metropolis with water, from places where the chalk is not loaded with superincumbent clay, I do not enter into any discussion. The subject was ably laid before this Society by Mr. Homersham, on the 31st January, 1855, in his paper "On the Chalk Strata, considered as a Source for the Supply of Water to the Metropolis." I refer to his paper for satisfactory information on this point.

Under date 21st of December, 1854, Dr. Hassall concludes a microscopic report to the General Board of Health, by whom he had been employed, in the following words, with which, too, I ask your leave to conclude this paper:—

"From all that has been now advanced in reference to the condition of the water supplied by the different metropolitan water companies, it appears that, during the period of this inquiry, when the cholera epidemic prevailed, as well as subsequently, the waters furnished by these companies were very far from possessing the requisite purity, in consequence of the large quantity of organic matter (which is the worst contamination to which water can be subjected) contained in them. Even in the water supplied by the Lambeth Company, which is comparatively the purest of the whole, organic productions, dead and living, animal and vegetable, are found in not inconsiderable numbers, and this water furnishes the type of that with which, in 1855, the greater part of London and its vicinity will be supplied, in accordance with the recent Act by which the water supply of the metropolis was regulated.

"The metropolis, then, after that year, will still continue to be supplied with river waters containing various kinds of organic matters, including numerous living productions. Now, that there is no necessity that this should be, has been clearly proved by the case of the Plumstead Water Company, which supplies a water entirely free from living organic productions of every description." *

DISCUSSION.

Mr. THOMAS WICKSTEED (of Leicester) said, in a note to the Secretary:—"I have, myself, no doubt that the effect produced by the process recommended by Dr. Clark is to soften certain hard waters. My late friend, Mr. Arthur Aikin, told me, about ten years ago, that he had been in the constant habit, for above forty years, of using lime to soften and clear New River water, whenever he required any for particular purposes in his laboratory; and my friend, Mr. Thomas Jennings, of Cork, told me, about the same period, that he had used lime for the same purpose nearly thirty years previously, upon a somewhat large scale, in certain operations carried on in his business as a manufacturing chemist."

The CHAIRMAN said, the meeting would no doubt be anxious to hear opinions on the subject of Dr. Clark's very interesting communication. The promise it held out of providing water free from hardness and organic impurities, was one of such great importance to health and comfort, that if it could be realised, the metropolis and the world might well be grateful to the author of the paper. He saw present some very distinguished chemists, who would probably assist in the discussion by giving their opinions; but as the author of the paper had made special reference to the engineer by whom the Woolwich Water Works—which might be called the model works, in relation to this subject—were constructed, and as Mr. Homersham was present, he hoped that gentleman would first favour them with some observations on the subject.

Mr. HOMERSHAM said, that about the close of the year 1852, he was called upon to design and construct the works necessary to supply the parishes of Plumstead, Woolwich, and Charlton, with water to be derived from the chalk strata. A plentiful supply of very good water was soon obtained from a small boring, and a well with adits or small tunnels communicating with it, driven in the chalk at a proper depth below the surface of the ground. The water was characterised by being always (summer and winter) at the same temperature, about 52° Fahr. It was fresh, clear, and bright, and well aërated, and when pumped up from the well was quite free from any putrescible organic matter. The water, however, as it came from the well, was from 20 to 21 degrees of hardness, and contained, in solution, both bicarbonate and sulphate of lime. As nearly the whole of the bicarbonate of lime, or chalk, could be taken out of the water by means of the process described in Dr. Clark's paper, he strongly advised the Directors to make use of the process, which they agreed to do, and after communicating with Dr. Clark, he (Mr. Homersham) designed and made the works requisite to soften about 600,000 gallons of water per day. These works had been completed and in use for the last eighteen to twenty months. The Company already supplied about 3,000 houses with the water softened to about 8 degrees of hardness. These 8 degrees were nearly all due to sulphate of lime. The number of houses supplied was rapidly increasing. The manner of carrying out the softening process at the works was as follows:—The lime used was flare lime, made from the upper chalk. Such lime, fresh burnt, was gradually slacked in small quantities in a tub with water, and was passed through a fine sieve, of about 10 meshes to the inch, into a cast-iron cistern. The cistern, which held about a day's supply when full, remained undisturbed for twelve hours, when a quantity of clear water, found to stand above the lime paste, was drawn off, and the lime paste or cream of lime, as it was called, was stirred up to make it all of a uniform consistency, when it was ready for use. A quart of such cream of lime contained in weight about 1lb., or rather more, of dry unslacked lime. As the water (about 900 gallons a minute) was pumped up from the well, a suitable quantity of this cream of lime was passed, by means of a large cylinder and piston moved by the steam-engine, into the pipe through which the water was conducted from the well. The cream of lime and water were intimately mixed by causing them to pass together through two, what were called, agitators, placed at a little distance apart. Between the two agitators, a well, six feet internal diameter, and open at the top, was interposed, so that all the lime and water, after it had passed through the first agitator, went into this well on one side, and passed out of it again on the other side, to the second agitator, on its way to the depositing reservoirs. The object of this well, which was five feet deep below the entering pipe, was to allow any gritty matter that by accident might be introduced with the lime into the water to fall to the bottom, and so prevent its passing into the depositing reservoirs. The agitator merely consisted of an enlarged pipe, 21in. internal diameter, and about 6ft. in length, containing within and around it 3 plates of wrought iron, about 2ft. apart, having

* Appendix to Report of the Committee for Scientific Inquiries in relation to the Cholera Epidemic of 1854, p. 271.

in them about 110 holes, each one inch in diameter. As the lime and water passed together through the holes at a speed of about 50 inches a second, they impinged quickly against the water in the body of the pipe, which moved only at the rate of 12 inches a second. The lime and water in this way became intimately mixed, and passed on together into a reservoir prepared to receive them, capable of containing (after leaving room for the chalk deposit at the bottom) 600,000 gallons, or one day's supply. The reservoir was divided into three compartments, each capable of holding 200,000 gallons, for convenience in emptying and filling. When the reservoir was being filled, the lime, at the commencement of filling, was added in excess to the water, so much so, that when the reservoir was only three-fourths full, the remaining fourth part was filled up with pure water from the well. In practice, the adjustment of the exact proportions of lime and water was very easy; the silver test was used for the final adjustment of each compartment of the reservoir, as described in Dr. Clark's paper. The reservoir being thus filled with lime and water, and adjusted by the silver test, in about 16 hours afterwards all the chalk or carbonate of lime had fallen to the bottom, the water had become perfectly clear, and it was then pumped up to the service reservoir for the supply of the consumers. When the reservoir was emptied of the softened water down to within about two feet of the bottom (so as not to disturb the deposit), it was again filled with lime and water as before, the deposit not being taken out until it was 17 or 18 inches deep; this did not occur more than once in eight or ten weeks. The pipe through which the water passed from the well, after the cream of lime was mixed with it, to the depositing reservoirs, was a closed cast-iron pipe, 14 inches in diameter, and about 75 yards in length. It was found for this length, at Plumstead, that the pipe got very slowly coated with a deposit of furr or crystallised carbonate of lime. The same kind of furring or deposit of chalk also took place in the agitators, but by making proper provision for clearing out the deposit which adhered to those parts, they could very easily be kept clear. He only mentioned the circumstance in order that any one adopting the process might make the provision for cleaning out the furr that he had alluded to in the first instance. Altogether the process was a very simple one in practice, and required no more attention than filtering did. In every respect the Company, by adopting the process, had realised all that Dr. Clark had led them to expect, or that he (Mr. Homersham) had expected. Upon the table was a sample of the deposited chalk, which was in as fine a powder as the finest whiting of commerce, and which had been brought that morning from the works at Plumstead.

Mr. Frederick Braithwaite said he had been invited to attend that evening and take part in the discussion upon the best and most efficient means of supplying the metropolis and other places with the best water from the best sources. He did not mean to complain that the discussion, so far as it had already gone, had not at all touched upon that subject, but it seemed to him simply to amount to an explanation of Dr. Clark's ingenious and excellent patent for depriving water of its chalky particles. He would take the liberty of differing from Dr. Clark as to whether it was so desirable to deprive the water of its chalk, for if he had read the works of Liebig and other chemists aright, it appeared to him that in some form or other—either in the drink or in the food—a certain amount of chalk was indispensible for maintaining the functions of animal life. There was an instance of an experiment tried by Liebig, of some pigeons breeding; the parent birds were supplied with drink and food from which all particles of chalk and lime had been extracted; the consequence was, the young birds hatched grew in the nest, but, as they never had any bones they were not able to quit the nest. The same kind of experiment was practised upon a breeding cow, and the consequence was, the calf was born, but it could not stand up because it had no bone. They had heard a great deal about the filthy condition of the water of the River Thames, and the large amount of salts and organic matter which it was said made that water so destructive to the health of the inhabitants of London. He could assure them it was a great mistake. He could tell them that a gallon of water taken from the Thames at Teddington-lock, and weighing 70,000 grains, was found to contain only from 20 to 29 grains of solid matter per gallon, the greater proportion of which was carbonate of lime, which he maintained was essential to the development of bone in animal life. Quotations had been made from the report of Dr. Hassall, as to the quantity of organic matter contained in the Thames water from samples taken from Teddington-lock down as low as London-bridge. The evidence given by one of the chemical witnesses was that in a gallon of water taken from Teddington-lock, he discovered 5 grains out of the 70,000 of organic matter. Upon further questions being put, it turned out that that was the result of the analysis of the average of water taken throughout the whole distance mentioned. A chemical witness was asked, "How much of organic matter did you discover in the water taken actually from Teddington-lock?" The reply was, "One and a half grains out of the 70,000." He (Mr. Braithwaite) asked the meeting seriously to look at this question. They had been told that they ought to drink spring water. He was at a loss to understand what was meant by the term "spring water." He had brought with him the results of analyses, and he hoped he should not give offence by laying the same before the meeting, because his sole object in attending was a desire to gain instruction, and also to impart what information on this subject he was in possession of. He found that for a great number of years past, noblemen and gentlemen of all shades of political opinion, during their periods of office, drank the water of the Treasury pump; and, although that water was beautifully clear and limpid, and highly agreeable to the taste, it nevertheless contained no less than from fifty to sixty grains per gallon of Dr. Clark's hardness. Yet they found the ministers flourishing; they did not hear of gout or other mischievous developments in the system arising from the use of that water; and he would say that almost all the finest land spring water pumped from the London wells was found to contain from 40 to 60 and even 100 grains of carbonate of lime to the gallon. The Thames was loudly complained of as a source for the water supply. In all valleys the waters must go more or less into the stream which intersected that valley; it was the same with the Thames. He was not prepared to condemn the patent of Dr. Clark. If he wanted to wash, he did not want lime in the water; if he wanted to make tea, he did not require to have lime in the water; in fact, for anything of a chemical purpose, Dr. Clark's process was, no doubt, a very valuable and useful one; but to tell them they were to precipitate the chalk and lime in water for all purposes was, he thought, using the term respectfully, ridiculous. It appeared that up to the present time, the Plumstead Water Works was the only place where they could find this pure and beautiful water that was so much recommended by the author of the paper. He had paid great attention, not only to the sources of water supplied to the metropolis, but also to the chemical condition of those waters, and it had been his misfortune to differ widely from chemists, chiefly from the fact that, the chemists differed widely amongst themselves on the subject. The observations of Dr. Clark in the paper read, applied to "the chalk waters around the metropolis." The metropolis itself was excluded from notice as regarded the chalk waters. They had under London perfectly soft water. If they pumped water from a considerable depth below London, so far from its containing 8 per cent. of hardness, there was, in fact, no carbonate of lime in it at all; but they had a large amount of carbonate of soda, sulphate of soda, and other salts in solution—even to an extent that was said by Dr. Clark to act medicinally upon the kidneys.

TABLE SHEWING THE ANALYSES OF THE THAMES CHALK AND OTHER WELL WATERS.

SALINE AND OTHER MATTERS IN ONE IMPERIAL GALLON OF 70,000 GRAINS.	Graham, 1844.			Brande, 1846.			Phillips, 1849.			Bostock, 1834.	Beale, 1841.		Campbell and Clark.		College, 1850.
	Greenwich Hospital.	Page's Well, Greenwich.	Lambert's Well, Deptford.	Brewery, London.	Trafalgar-square.	Royal Mint.	Camden-town Station.	Watford Station.	Tring Station.	Treasury Pump.	Roberts, Roehampton.	Roberts, Roehampton.	Trafalgar-square.	Trafalgar-square.	Trafalgar-square.
Carbonate of Lime	19.08	21.23	16.74	6.2	3.1	1.5	...	19.54	14.72	34.3	48.0	24.0	2.74	...	3.2704
Carbonate of Soda	...	...	...	11.7	14.6	12.0	17.60	...	...	...	...	...	10.58	...	18.2840
Bicarbonate of Soda	...	...	...	...	...	...	...	...	...	..	...	...	...	28.5	...
Sulphate of Soda	3.62	0.60	2.67	24.2	19.6	18.1	13.0	...	...	...	8.0	8.0	21.34	...	8.7493
Sulphate of Potash	...	...	...	...	...	...	...	...	...	...	...	...	...	...	13.6710
Sulphate of Lime	0.52	...	...	...	...	...	...	0.94	1.09	16.1	32.0	24.0	...	...	...
Chloride of Sodium	0.37	3.12	1.91	12.7	25.7	8.3	11.10	1.90	1.38	12.6	16.0	8.0	19.04	...	20.0583
Carbonate of Magnesia	...	...	0.84	1.1	2.4	...	...	...	...	...	...	...	2.07	...	2.2540
Sulphate of Magnesia	2.04	2.88	2.75	...	...	...	...	...	...	...	...	...	...	51.3	...
Carbonaceous Matter	...	...	...	...	...	...	2.30	1.32	1.61	...	...	...	...	...	...
Silica	...	...	...	0.4	0.7	...	...	...	...	...	...	...	0.40	...	0.9718
Phosphates	...	...	...	0.4	t	t	...	...	...	...	...	...	0 97	...	0.0210
Loss	1.67	...	1.33	...	...	...	...	...	...	...	...	...	0.66	...	...
Carbonate of Potash	...	...	...	...	...	...	...	...	...	...	...	...	1.05	...	...
Total	27.30	27.83	26.24	56.7	66.1	39.9	44.00	23.70	18.80	63.0	104.0	64.0	58.85	79.8	67.2798

The above table showed the results of various analyses of the so-called chalk water made by different chemists, and all differing in their results. He might mention the names of Prof. Brande, Dr. Clark, the College of Chemistry, Mr. Phillips, Mr. Dugald Campbell—in each of whose analyses there was a very wide difference as to the chemical composition of the water. It was, therefore, only fair to ask for some explanation on this subject. As he had before remarked, Dr. Clark, in his paper, had dwelt upon the matters *around* London. He (Mr. Braithwaite) wanted to know, if he could produce them water in London free from carbonate of lime, why they should pass a sweeping condemnation upon the Thames as a source for the supply of water to the metropolis. Dr. Clark had said, taking the water of the Trafalgar-square well, he found 79 grains of solid matter to the gallon, consisting principally of soda salts. Mr. Dugald Campbell had put the quantity at 58 grains, the College of Chemistry at 66 grains, and the College analysis appeared to be extremely minute, inasmuch as it was carried to six places of decimals. Prof. Brande stated that he found 66 grains of solid matter in that water. What he (Mr. Braithwaite) wanted to know was—and he had expected Dr. Clark would have stated it in his paper—what better source than the Thames they could go to? because, taking the 23 or 24 grains of solid matter to the 70,000 grains of water, he knew of no other water so good. They ought not to alarm the public by saying that in drinking the Thames water they were liable to be poisoned. He could tell them that, from an analysis ordered by Government, a gallon of water taken at the present time from Teddington lock did not contain more than 1½ grains of organic matter to the 70,000 grains of water, so that they might go home relieved of the unpleasant idea that they were going to be poisoned from drinking the Thames water.

Dr. LANKESTER stated that he thought, in consequence of the still imperfect nature of the water supply in London, that Dr. Clark was justified in calling the attention of the public to his method of purifying water, and that the Society of Arts was to be commended for having permitted his paper to be read. He first alluded to the objection which had been raised to Dr. Clark's process, as taking away lime from the water, and which was probably necessary for forming the bony and other structures of the human body. In answer to this, he stated that in many towns of the kingdom water perfectly free from carbonate of lime was habitually drunk, and had been drunk from time immemorial, and yet no softening of the bones or other injurious effects had been produced. The fact was, that carbonate of lime, although present to a certain extent in the bones of animals, was not the salt of lime they needed, which was the phosphate, and which was seldom found in water at all. It was another question as to whether carbonate of lime did any harm when taken in large quantities. There was evidence to prove that it was injurious, and most physiologists were agreed that pure water was the best for securing the health of animals and man. It had been stated that the organic matter in the Thames was in too small quantities to do any harm. It was impossible to say how small a quantity of organic matter in a state of fermentation might not do harm. A very minute quantity of organic matter present in water containing soluble sulphates was sufficient to decompose them, and render the water offensive from the discharge of sulphuretted hydrogen. This had even led the late Professor Daniell to conclude that the water of the Niger and the sea water off the coast of Africa contained sulphuretted hydrogen. In the water of the pump in Broad-street, Golden square, which he had investigated, only very small quantities of organic matter could be found, yet there was no doubt that the organic matter of this water was in such a state between the 1st and 3rd of September, 1854, as either directly to communicate or predispose to take the cholera to upwards of 500 people who partook of that water. The last speaker had begged the Society not to listen to "microscopic twaddle," but he (Dr. Lankester) begged the Society to attend to the results of microscopical investigation. A quantity of organic matter, not appreciable by chemical analysis, could be made abundantly evident by the aid of the microscope, and the forms of minute animal and vegetable life, which could alone be detected by the microscope, were frequently more characteristic of the impurity of water and its unfitness for dietetical purposes than any chemical analysis. The advantage of Dr. Clark's process in purifying water for cooking, washing, and manufacturing purposes, was admitted by all, but it had this additional recommendation, that it took away the source of organic impurities. It was the carbonic acid which favoured the growth of plants, and these were followed by animals which subsequently died, and led to much impurity. The carbonic acid being removed by Dr. Clark's process, stopped at least one source of the impurity of water. It was a sad reflection that after all the complicated arrangements for the supply of water to the metropolis, there was no general supply of water that could be guaranteed as free from impurity, and even occasional danger to life. The Thames, both above and below Teddington lock, was the recipient of all the filth from the vast population of the valley through which it

flowed, and no efficient means of purifying it had yet been adopted. It was only fit for scrubbing, washing, and flushing the sewers, and he would suggest that means should be taken for supplying in small pipes, for drinking purposes alone, some of the pure spring water at a distance from the metropolis. He was glad to find that Dr. Clark's process had so perfectly succeeded at Plumstead, as it led to the hope that attempts would be made to bring water of equal purity to the large population of London.

Mr. RAWLINSON inquired whether any particular description of burnt lime was necessary for the process?

Mr. HOMERSHAM replied, that all kinds of lime would not do. The description he used was the flare lime, from the upper chalk, near Gravesend. There was a lower bed of the chalk, known as the grey lime, which contained clay; that would not do, as the clay would contaminate the water. The cheapest lime that could be procured was the upper chalk lime, and that was applicable for the purpose. He (Mr. Homersham) had had it analysed, and found that it contained 98 per cent. of pure carbonate of lime.

Mr. RAWLINSON further inquired whether the process could been carried on in, or was affected by, air and light, and whether it was necessary to be carried on in a closed reservoir?

Mr. HOMERSHAM replied, that it could be conducted either in a light or a dark, or in a covered or an open reservoir.

Mr. RAWLINSON mentioned that in Manchester the water was under 2 degrees of hardness; in Lancaster, it was under 1½ degrees of hardness; and in Keswick, where he was at present constructing water-works, the water was under half a degree of hardness. He had not heard of any complaints of the use of soft water for drinking purposes. People accustomed to hard water considered soft water at first vapid and tasteless, but when they became habituated to it they approved of it; and when they left their homes, and drank hard water, it was offensive to the palate.

Mr. EVANS remarked that, with regard to Dr. Clark's process, it certainly would appear that it was very efficacious in removing a large proportion of the lime usually held in solution in spring and river waters, and that such a subject would appear to be a legitimate one to bring under the notice of this Society. But what he had to complain of was, that Dr. Clark brought this scheme as only applicable to spring water, and as a round-about means of again bringing Mr. Homersham's Watford spring-water plan under the notice of the public. He, therefore, called the attention of the meeting to the fact that if it was valuable for spring water, and was capable of removing the organic impurities of decomposing chalk-water, it would be equally applicable to the lesser impurities of the water supplied by existing companies, and there was no need of seeking for fresh sources of water-supply for the metropolis, on which to bring Dr. Clark's process into operation.

Dr. ROBERT DUNDAS THOMSON, F.R.S. (Medical Officer of Health for St. Marylebone, and Professor of Chemistry at St. Thomas's Hospital), regretted that a preceding speaker, eminent as an engineer, should have led the discussion aside into physiological subjects, for which the Society of Arts was not the proper arena. The invitation which he had received was not to discuss the proper source of lime for animals, but whether the process of Dr. Clark (and it was admitted by all who had addressed the meeting to be a beautiful one) was applicable for the removal of chalk and organic matter from waters capable of being supplied to the metropolis. When, during the invasion of cholera in 1854, he had to report to Government on the sanitary condition of the waters of London, he had considered it proper to study the invention as carried out so successfully at Plumstead, and he had satisfied himself that the process was not only excellent in theory, but likewise admirable in practice; and he could have wished that engineers, instead of travelling out of their province, and advising as to the physiological questions involved in the subject of food, had been prepared, by a careful study of the process, to point out any difficulties as to its application, or to suggest facilities for adapting it to the improvement generally of waters impregnated with chalk and organic matter, such as those of the metropolis. There could be no doubt that the process successfully removed chalk, and several chemists, qualified to express an opinion, had affirmed, from their experiments, that organic matter was likewise separated from the water by the use of the liming process. It was often asserted by non-medical participators in this discussion, that the small portion of organic matter in Thames water could not act injuriously to health. This, however, was a physiological question, and could only be argued legitimately in a Medical Society. But even in a popular meeting it could be understood that minute quantities of organic matter were capable of producing extensive results, for who could weigh or estimate the infinitesimal or imponderable portion of organic vaccine matter with which we inoculated our patients, and which was yet capable of influencing a whole community. The chemist found in Thames water ammonia and nitric acid, which, it was true, were not dangerous in themselves, but they were proofs, when present beyond certain limits, that the river was contaminated from the foulest sources with organic matter. He trusted that the meeting would not lose sight of the main object of the paper, which was an all important one in a sanitary point of view, by the foreign matter which had been introduced into the discussion. He had been astonished to find that when he was engaged, in 1854, in examining the process of Dr. Clark, he had not met with any engineer connected with water works who had examined the Plumstead successful experiment, or who was even aware of its existence, and he had never heard any reason assigned for the neglect of the process by the water companies, although competent chemical authorities had reported favourably as to the applicability of the invention to the purification of the Thames water.

Dr. MILLER, F.R.S. said, having had an opportunity of witnessing experiments on the purification of water by Dr. Clark's process on a large scale, it might not be without interest if he stated one or two of the results obtained. He had seen Dr. Clark's process applied both to the water of the Thames and the water as raised from the well at Plumstead. A great deal had been said as to the importance of clearing the water, not only of the lime, but also of the organic matters present in the Thames water. It was quite certain that this process as applied to the Thames water, removed a large portion of organic matter as well as of chalk, and he had seen the experiment tried upon 3,000,000 gallons at Chelsea; on three different occasions a day's consumption of water at Chelsea was subjected to Dr. Clark's process. A specimen of the water was taken before the lime was added, and also a specimen after the water had rested in the reservoir for twenty-four hours. The water was examined for organic matter after the lime had been added, when it was found that the quantity of organic matter had been reduced to one-third of what it was before the lime was added,* whilst the precipitate was of a decided brown colour, in consequence of the organic matter carried down with it. Therefore, as applied to Thames water, he would state that the process not only removed the chalk, but, to a very considerable degree, reduced the amount of organic matter contained in the water. There was, however, one objection to the use of lime as applied to Thames water, but he did not regard it as an insuperable objection, which was, that on the application of lime, the water required a longer period of time to become clear, and, if there was any clay in suspension, it would not become perfectly clear upon the application of lime. He

* It was subsequently explained, that this referred to matter *in solution*, not merely to that in suspension.

would further state that he had seen the process of Dr. Clark in operation at Plumstead, and was much gratified at the appearance of the water. It was bright before the lime was applied, but, after the process, it was extremely bright, had an excellent taste, and was reduced in hardness to the extent stated. He would say one word with regard to the use of lime. It had been debated that evening whether it was advantageous to remove the chalk from water. No doubt salts of lime in certain proportions were essential to animal life and the proper development of the frame. They could not exist without lime in some shape, either in their drink or their food, but it was another question whether it was desirable to supply it in the water they drank. There was scarcely an article of food that they took in which lime was not present. Every piece of bread they ate contained lime, and in most kinds of human food a larger quantity of lime was contained than was necessary for the preservation of life. A quantity of lime was removed from the water by this process, but it was very trifling in amount compared with what was introduced into the animal system from other sources than the water they drank.

Mr. DUGALD CAMPBELL, F.C.S., said he would, if allowed, take up the subject of discussion at the point last touched upon by Dr. Miller, which was the supply of lime salts to the bones in the body. He thought it had escaped the notice of the previous speakers to mention that the phosphate of lime was the salt of lime essential to the support of the bones in the body. In the bread, in the vegetables, and in the meat which we ate, there was an abundant supply of that salt—the salt proper, as it might be called, for that duty—whereas water, as a rule, contained none of it. The principal lime salt usually found in water was the carbonate, and this salt bore a small proportion to the other salt of lime in the bones, as Dr. Lankester had truly observed, and he (Mr. Campbell) thought, need not essentially be supplied by the water, as carbonate of lime was in superabundance in the substances supplying the phosphate of lime, and might be assimilated at the same time along with it. He had frequently witnessed the process of Dr. Clark at the Plumstead Water Works, where it had been applied with such great success by Mr. Homersham, the engineer to the company. He happened to be there a few days after the company had tried the experiment of supplying the unsoftened water to the consumers, which was alluded to by Dr. Clark in his paper, and he regretted to witness those reservoirs, which he had previously seen free from vegetation, then covered with vegetation of a decidedly obnoxious appearance and odour, which was sure to arise in all chalk waters left unsoftened and exposed to light and air in warm weather. He had witnessed on a large scale the application of Dr. Clark's process to the Thames water, and had softened it himself on many occasions, but although, under all circumstances, it greatly improved the water, yet, to apply the process to the greatest advantage, the water should be previously filtered, and even then, after the trouble and expense of filtration, the water softened was not equal to water softened direct from wells, which needed no filtration. Rather more than twelvemonths back he took up a number of the *Comptes Rendus*, a very well known French scientific journal, and seeing a title inviting to him, which was "A new Method of Analysing Waters for Household Purposes," by MM. Boutron and Boudet, he began to peruse it with great avidity. As he read he found described, word for word, Dr. Clark's method for testing water to guide persons in applying his softening process, all of which was published to the world fifteen years back. He thought of course to come to the words, "this is the process of Dr. Clark, and now we will describe ours," but no, Dr. Clark's name was not mentioned, but MM. Boutron and Boudet claimed the method, without the slighest reserve, as their own. This astonished him, but what surprised him more,—for he thought the French men of science, as well as those of this country, must know the process as being Dr. Clark's,—was being told by Dr. Hofmann, some little time ago, that the French Academy had awarded to these two gentlemen a prize of about 2,000 frs. for this discovery. The award to these gentlemen was a mistake on the part of the French Academy, but it showed how the Academy, composed of the highest talent of France, appreciated the value of the discovery, by distinguishing it with a prize within twelve months after its production. It might be observed that this was only one-half of Dr. Clark's invention, and the smallest half, perhaps, in many ways, all o which, as stated before, had been open to this country for fifteen years, yet it had received no prize, and, as yet, had only been embraced by one solitary public company.

Dr. HOFMANN, F.R.S., said, he could confirm in every respect the statement of Mr. Dugald Campbell. The beautiful process of analysing water by means of an alcoholic solution of soap, a process which had been universally in use in this country for the last ten years at least, had been rediscovered in France. This event took place on the 26th of March last year, when Messrs. Boutron, Chalard, and Boudet communicated a note on this subject to the French Academy. The communication of these gentlemen, the essence of which was Dr. Clark's process, for which they claimed, however, a more extended application, attracted much notice in France, and on the 28th of January last, the Academy voted them a recompense for their invention, consisting of 2,000frs., to be taken from funds left at their disposal by Mr. Montgon, (*Prix Montgon relatifs aux Arts insalubres*). The reward was made in the following terms:—"*D'accorder un prix de 2,000f. à MM. Boutron et Boudet, pour leur moyen de determiner la proportion des sels à base de chaux et de magnésie dans les eaux des Sourres et des rivières au moyen d'une liqueur savoneuse titrée.*" This proceeding might appear strange perhaps, but he (Dr. Hofmann) had not the slightest doubt that the process had been actually invented again by Messrs. Boutron and Boudet, who had remained perfectly unacquainted with what Dr. Clark had done previously. This would be readily intelligible to those who knew how little public attention in France, and on the Continent in general, had been, until recently, directed to the question of water supply to towns, and to the means of purifying water for domestic purposes. As to the award made by the French Academy, it was nothing but a recognition on their part of a most useful and elegant process, and had they been aware of the general use of this process in this country they would have doubtless done ample justice to Dr. Clark. Even now it was not too late, and he believed it would only be necessary for Dr. Clark to submit a simple *reclamation* to the French academicians, as a more conscientious, just and liberal body of men could not be found. Such a step, he had no doubt, would be highly acceptable to Messrs. Boutron and Boudet, who he was persuaded had no wish to claim anything which was not due to them. It would be appreciated equally by the Academy, who would be thus afforded the means of healing a wound which they had unintentionally inflicted. He would strongly urge Dr. Clark to take this step, which would settle this matter in a manner satisfactory to all parties. With regard to the subject more immediately under discussion that evening, he could add but little to the able remarks which had already been made. He had himself witnessed Dr. Clark's process on a very large scale, both at the Chelsea Water Works with Thames water, and at Plumstead, and he could bear testimony to the remarkable results obtained by this elegant process. A great advantage of Dr. Clark's method consisted in the removal of the lime, but a much more important feature was the removal of organic matter from the waters, or at all events, the reduction of the organic matter invariably present in water, to a condition in which the water was incapable of undergoing putrefaction under the influence of a high temperature. He had himself observed a diminution of the organic matter in consequence of the softening

process; he could also testify to the remarkable absence of confervæ in the softened water of the Plumstead Water Company, but he was not at present prepared to give a definite opinion regarding the perfect success of the process in the removal of the total amount of organic matter. He might state, in conclusion, that in his opinion, the fear entertained by many persons with regard to the present supply of water to the metropolis, was somewhat exaggerated. He had himself had frequent opportunities of examining the present supply, and was at present engaged in an extensive series of experiments, undertaken under the auspices of the President of the General Board of Health, embracing the waters of all the companies taken at regular intervals, so as to obtain an idea of their composition in the different periods of the year. Without entering into details, he might state that the results obtained up to the present moment, which referred to the composition of the water during the winter months, had been very satisfactory. It remained, however, to be seen in what manner the composition of the water would be affected by exposure to the high temperature of the summer months.

Mr. BEARDMORE remarked, that in discussing the best means of affording a pure supply of water to the metropolis, due regard must be had to its position in the centre of a great basin entirely encircled by chalk hills, from which poured, in every direction, rivers composed of springs rising directly out of the chalk, the chief bulk and volume of which lay within twenty-five miles of St. Paul's. It was no doubt natural enough for people to cry out at the impurity of the Thames, seeing the state in which it flowed through the metropolis, owing to the sewerage proceedings of the past ten years—but it did not follow because such was the case below Teddington, that the chalk springs formed to any less degree the main volume of the river above that point. Since 1853, the companies had, in deference to public opinion, removed their points of draught, improved their works, and applied the most practicable means of purification yet known, on the broad and immense scale which the demands of two millions of people required. The monies spent upon these great operations would exceed fifteen hundred thousand pounds sterling; a sum which, first or last, would fall upon the householders for repayment, and it therefore became a matter of discretion how far the beau ideal of purity could be economically attained. He would not, therefore, either encourage or discourage the consideration of the author's very ingenious process, deeming it to be just one of those inventions which rested upon the debateable ground between theory and practice. The supply of water to towns was always a geological and geographical question in connection with the economical application of capital, and it therefore would be equally just and necessary that Manchester, or Carlisle, or Plymouth should drink water containing two or three grains of carbonate of lime per gallon, as that the towns on tertiary formations should consume water with twelve grains of that salt in a gallon. He was surprised at the want of knowledge of the locality shown by a remark in the paper on the New River Company's source of supply from the River Lea. The meeting might, perhaps, be informed that the entire body of that river was, for all practical purposes, pure spring water, and differed to no appreciable extent from the Chadwell spring, which formed only from one-sixth to one-eighth part of the present requirements of the New River Company's district. The River Lea was formed, to the extent of four-fifths of its entire volume, of chalk springs, rising either in its bed or within a few yards of its banks—the sole exception to the case being during times of flood, when artificial aid in the purification of waters was at all times more particularly required, and to which object the enormous expenditure of the companies was largely devoted. Any mention of the supply of the metropolis from the Thames must, therefore, admit this qualification—that the area supplied with water taken from the Lea at points from 14 to 22 miles above its junction with that river was girt by a line extending from Charing Cross to Highgate—from Highgate to Tottenham, from Tottenham to the new town springing up at the Victoria Docks, and thence along the Thames shore line, all the way up to Whitehall stairs—a circle which embraced no mean proportion of the urban and suburban metropolis, whether as regarded extent or population.

The Rev. J. C. CLUTTERBUCK had been acquainted with Dr. Clark and his process for softening water for nearly fifteen years. He then tried the experiment himself, and forwarded many samples of water from Hertfordshire to Dr. Clark for examination. He could not persuade his servants that there was so much difference in the water as he was led to expect, though he was willing to attribute this to his want of skill in the experiments. He had lately heard it observed, that in all the places which of old were famous for their beer, the water was either from the chalk, or else was highly charged with carbonate or sulphate of lime, so that it had been suggested that where these substances were wanting it would be well to introduce them artificially. This was a fact he thought worthy of notice. With reference to the natural supply of water to London, it was mostly from the chalk; even the river Thames, which rose in the oolitic hills of Gloucestershire, and then passed over the clay districts, (where it became charged at times with the impurities from flood waters,) received the greatest part of its perennial waters from the chalk. On a recent occasion, when the waters were very low, there was so little water above Pangbourn that at that place all the gates of the lock could be opened at one time, showing how very little perennial water came from the upper districts; thus the Thames was a water well fitted to be dealt with according to Dr. Clark's process, if it were deemed advisable to incur the great expense it would entail on the water companies, and for which the public must pay. It appeared to him that the statements of the paper with reference to the removal of organic matter were not sufficiently explicit or detailed. Some light had been thrown on this point in the discussion by a previous speaker, but the meeting was not told in the paper how the removal of organic matter was effected. The carbonate of lime was removed by a chemical action of the lime, or lime-water, on that substance. This was thoroughly explained. But we were not told whether the removal of the organic matter was confined to that held in suspension, and so carried down by the gradual deposition of the chalk or lime, or whether its removal was by some chemical action. Mr. Clutterbuck thought that this was a point well worth attention, and which required elucidation, because, as had been argued, the presence of organic matter was much more dangerous, and either directly or indirectly more deleterious than the presence of carbonate of lime, to the removal of which it was generally supposed that the process was confined. If Dr. Clark could prove that organic matter was effectually removed from water by his process, it would be impossible to over-value the discovery or the benefits of its application.

Mr. W. FOTHERGILL COOKE would mention a fact, which he took from an official report by Mr. Wicksteed, as to the disinfecting action of that gentleman's process upon the entire sewage of Leicester during many months. The organic and mineral matter deposited by the cream of lime was about one part in 1,100, including the lime employed. The effluent water was almost entirely free from taste, and frequently from colour, and very soft and in a drinkable state. It was believed to be nearly as pure as the average drinking water of London, which contains 23 grains in a gallon or in 70,000 grains, or 1 in about 3,000. The conclusion, therefore, would be that the sewage of Leicester was only four times more charged with separable matter than the drinking water of London. The dry solid sewage separated at the works during the last nine months was about 3,000 tons, from 3,400,000 tons of sewage.

Mr. FREDERICK BRAITHWAITE wished to say, in explanation, that Mr. Cooke had omitted one important element in the comparison he had brought forward of Mr. Wicksteed's sewage water and the water used for drinking purposes in the metropolis. If he took away the 20 grains of lime, there would only be left 1½ grains of solid matter per gallon in the London water. In the remarks he had offered he had not wished to detract in the smallest degree from the merits of Dr. Clark's process. For all matters of washing, dyeing, and brewing, ind ed, for all culinary purposes, there could be no question but that it was valuable in the extreme.

The CHAIRMAN said he was reminded by the Secretary that the time had arrived at which—however willing some of them might be to continue to listen to the important observations that were being made—this discussion must be closed. It would be unpardonable in him, who could add but little to the information already given, to detain the meeting with many remarks. The only part of the subject on which he would say a few words, was that which had already been touched upon by a distinguished member of his (the chairman's) own profession, Dr. Lankester, but which otherwise had, perhaps, received less attention than its importance deserved—that was, the *real value to human life* of the project of Dr. Clark, supposing its adoption to be chemically and mechanically feasible. Dr. Clark proposed to free water from hardness and from organic impurities. First of all, as to freeing it from hardness. Was hardness in water in any degree hurtful to life? That was a subject on which he could not speak dogmatically, but he would contribute his humble testimony towards relieving the meeting from whatever anxiety had been occasioned by the speech of Mr. Braithwaite. Was there any chance of their bones failing them in case soft water drinking should be resorted to? He thought he might say evidence on that subject had been adduced sufficient to satisfy Mr. Braithwaite's mind that his position was not tenable, inasmuch as large populations had been mentioned who habitually consumed soft water—in Aberdeen, in Manchester, in Lancaster and elsewhere—populations certainly showing no deficiency of bone. Experiment was, indeed, the final test in these matters; but, let the experiment be a sufficient one. The conclusion which had been drawn from Professor Liebig's cartilaginous calf evidently was inadmissible. Myriads of cattle throve on soft water. The skeleton of any one of them might be confidently produced to meet the argument of Liebig's boneless calf. Take much of the Highland cattle, for example; they had well-formed bones, and were not obliged to be supported on calves-foot jelly. The fear was evidently groundless that the human body could be starved of lime by the mere absence of that material from the drinking-water. Plenty of lime was to be found in other ingredients of human food; and for the most part it occurred in our solid food, in a more immediately available form than in water. He was not prepared to say that they had as yet any very definite evidence on the question whether hard water was in itself injurious to health; there was hitherto a want of that sort of proof with which a physiologist ought to satisfy himself; but of the domestic and economical advantages of soft water there could, he believed, be no doubt. As regarded the other matter—the freeing of water from organic impurities—he must say that, if Dr. Clark could realise that promise, he would have fulfilled an important object for human life. Mr. Clutterbuck had raised a question, not previously mooted in the discussion, but which was of essential importance. It was one on which Dr. Clark had not supplied any definite information. The liming process was described as clearing the water of organic impurities. No doubt it would have that effect upon such organic matters as were held in suspension. But did it free the water from organic matters not in suspension, but in solution?

Dr. MILLER stated it was used at the print works in Manchester for that very purpose.

The CHAIRMAN said, that as regarded the most objectionable impregnation of organic matter (that which would be occasioned by an admixture of town drainage), so late as that day he had asked a friend, who was now present, and whom he had hoped to hear speak on the subject, Mr. Taylor, to investigate this point. This gentleman informed him that he had applied Dr. Clark's process to water having those qualities that were attributed to the worst conditions of Thames water; that, after liming, he had filtered it; that it had passed the filter quite clear, but still preserving a very unmistakable smell, and when evaporated giving evidence of the presence of organic matter. All suspended organic matters, and all colouring matter, had been removed by the liming process; but the water retained offensive qualities, and still contained sewage ingredients liable to putrefactive changes. That was the real danger which he (the chairman) apprehended in many of those waters in which the public of large cities were most interested. Organic admixtures in water were various, and of course not all of equal importance. In some cases the material might be of a kind or in a state importing no danger to health; but when of a kind easily putrifiable, he suspected it was extremely dangerous; and when this putrifiable quality was derived from the drainage of towns (when, in fact, it represented the decomposition of sewage) he suspected the danger reached its maximum. He could quote to them the results of a gigantic experiment which had been undesignedly conducted on half a million of human beings, and which would set this fact in a strong light. It happened that in the last epidemic of cholera, a certain half million of population dwelling contiguously over one large area were drinking different waters; some from private wells, but the larger number (about four-fifths of the whole) from two commercial supplies. There were the mains of two rival water companies going through the district, often literally side by side; one company supplying nearly 25,000 houses, the other nearly 40,000; so that in this vast experiment there were immense masses of population living, as far as could be judged, in all respects alike, except as to the one difference of their water supply only. And that difference was, that one company drew its water from high up the Thames, where it was of comparative excellence, while the other drew its water from low down the river, where it was profusely contaminated with town-drainage. Among the population to which he alluded, there were in 1853-4 more than 4,000 deaths from cholera; and when the epidemic had subsided, an inquiry was made, house by house, as to those deaths, and as to the water-supply of the several houses where they had occurred. The inquiry was conducted with every precaution, to avoid sources of fallacy; and the result was this: In the one set of houses the mortality per 10,000 of the population was 37; in the other set of houses it was 130, that is to say, the cholera death-rate was 3½ times as great in the one set as in the other. It also fortunately happened in this very decisive case that further information could be procured, so as to present almost a duplicate experiment. The returns of the Registrar-General had made it possible to ascertain the mortality during the preceding epidemic of cholera—that of 1848-9. Going back to that period, it was found that the mortality from cholera was about equal in the two groups of houses. The mortality per 10,000 of population was in the one case 125 and in the other 118. The tenantry which in the epidemic of 1853-4 suffered a cholera death-rate of only 37, had in 1848-9 suffered a death-rate of 125, and why? At that time, instead of drawing a comparatively pure supply from high up the river, it was drawing from nearly the same source as that other company which, on the late occasion, contrasted so unfavourably with it. Now, these unintended experiments had been on so large a scale that they might be considered conclusive, and as

the difference between the two waters in question was only that one of them contained a large admixture of town drainage, they might be considered to establish the extremely dangerous tendency of this contamination during periods of epidemic cholera. Among the population supplied with foul water, the death-rate was three or three-and-a-halt times greater than among those who had the advantage of a more wholesome supply. With this fact before them, the importance of Dr. Clark's project could not be mistaken. If they were to continue the use of waters liable, in however small a degree, to such admixtures, there could be no doubt that any available process which would thoroughly withdraw such organic impurities, would be an invaluable boon to society. Having referred to the water-supply of a particular company as the hurtful agent in that large experiment which he had described, he now begged in conclusion, to assure the meeting that they need entertain no apprehension of being injured by the further distribution of that water which, during the two epidemics of cholera, did doubtless cause a great destruction of human life; for, happily, it was no longer furnished; the company had now, for some months past, altered thieir source of supply, and were at this moment distributing a water widely different from that which had been the subject of his remarks.

A vote of thanks having been passed to Dr. Clark for his paper,

The Secretary announced that there would be an Extra-Ordinary meeting on the evening of Friday, the 16th inst., for the purpose of resuming the discussion upon Mr. Braidwood's Paper on "Fires and Fire-proof Structures." John Thwaites, Esq., Chairman of the Metropolitan Board of Works, will preside, as on the last occasion. Also, that the Paper to be read on the evening of Wednesday next, the 21st inst., was, "The British Silk Manufacture, its Condition and Prospects as Compared with that of other Countries," by Mr. T. Winkworth. On this evening T. F. Gibson, Esq., F.G.S., will preside.

Mr. W. Bridges Adams, in a note to the Secretary, subsequent to the meeting, on "Pure Water and Railway Locomotives," says, "In the paper on pure water, by Professor Clark, read this evening, there was no mention either in that or in the subsequent discussion, of one very important branch of the subject—the applicability of Professor Clark's system to the purification of water for railway locomotives. It is probable that the duration of boilers and the production of steam, *quoad* the fuel consumed, are lessened from one-half to two-thirds by lime deposits. Organic matter is of little consequence for such uses, for the best known water in practice is the water of peat bogs, containing tar and other matters. With pure water, the boiler would scarcely ever need blowing off or washing out, and tubes and piston would be saved from burning. Many plans have been prepared and tried for preventing incrustation in boilers, by trying to alter, chemically, the condition of the water when in the boiler, but, unfortunately, with the too frequent chemical result of altering the chemical condition of the metal composing the boiler. Using distilled water, or water freed from every ingredient not essential to the production of steam, would add very materially to the profits of the railway companies, and to the safety of their servants and the public. The process of Professor Clark could, at little expense, be adapted to all water stations, and probably would, were the railway authorities made aware of it. I think it would do good service, and be very likely to promote a useful object, if the number of the *Journal* with Mr. Clark's paper and discussion, were forwarded to every locomotive superintendent throughout the kingdom, as a common-sense process for saving coke, facilitating the production of steam, lessening wear in the boiler, diminishing the number of engines required, and leaving the hot water all night in the boiler, instead of blowing it off as waste. I have no doubt that it would pay, even to distil all the water before using it in the boiler, so great is the waste arising from the use of impure water. If, therefore, Professor Clark's process will accomplish this in so simple a manner, the saving will form no unimportant item in the dividends."

BRAKE FOR RAILWAY CARRIAGES.

Previous to the reading of the paper on Wednesday evening, the Secretary called attention to a model of a brake for railway carriages, by Mr. George S. Parkinson, which was placed on the table. This invention consists in attaching a fixed and a moveable "clutch" on one of the axles of a railway carriage, and to the collar of the moveable clutch is attached a cam. The moveable clutch is put in or out of gear by means of a long rod, working a system of levers. The rod is worked from the guard's carriage by means of chains attached to a drum. The drum being made to revolve by a screw, worked under the control of the guard, the chains are wound up and the rods drawn, which, by means of the levers throughout the train, cause the moveable clutch on each carriage to be brought into gear with the fixed clutch. The cam attached to the moveable clutch is thus made, on every revolution of the axle, to press against a lever, by which the jambs of the break are brought to bear against the rim of the wheel, during a portion only of its revolution. By this arrangement the wearing of the wheel into "flats" as at present, is said to be prevented, and less destruction is caused to the rails and jambs. It is intended that this invention should be used on two carriages of a train at least, and it can also be applied to work on any number of carriages simultaneously.

ALUM.

(From Dr. Macgowan's Chinese Serial; as reprinted in the *North China Mail*, Feb. 23, 1856).

About eleven hundred tons of alum have been exported within a short period, chiefly to India. This mineral is largely employed by the Chinese in dyeing, and to some extent in paper-making, as with us. Surgeons apply it variously, after depriving it of its water of crystallisation; and in domestic life it is used for precipitating vegetable substances suspended in potable water. It is used also by the Chinese in a manner peculiar to themselves. Fishermen are usually provided with it; and when they take one of those huge Rizostoma which abound on the coast, they rub the animal with the pulverised styptic to give a degree of coherence to the gelatinous mass. Architects employ it as a cement in those airy bridges which span the watercourses. It is poured in a molten state into the interstices of the stones; and in structures not exposed to constant moisture the cohesion is perfect, but in damp situations it become a hydrate and crumbles, a fact of which the whole empire was officially informed by the government about thirty years ago. It was discovered that water had percolated into the mausoleum of Kiaking; having been built too near to the mountain side the alum cement imbibed moisture, segregated, and opened the way for it to enter the tomb. In those peaceful days such an event was of such importance as to call forth edicts and rescripts, memorials and reports, in succession for several months. The son-in-law of the deceased monarch, to whose care the construction of the edifice had been entrusted, was fined and degraded, and a statesman from Foh-kien, acquainted with the properties of alum, was appointed to remove it a short distance from the mountain.

Alum was first introduced into China from the West,

and until a comparatively recent period the best kind, called sometimes Persian, and at others Roman alum, was brought from Western Asia. Numerous localities where an inferior article is manufactured are mentioned in the Pharmacopœia—viz., Shan-tung, Shan-se, Kiang-su, Hu-kwang, Sz'-chuen, also in the south-western frontier and in Tibet. That from Sz'-chuen is represented as having the property of converting iron into copper or of coating iron with copper, by placing the former metal in a solution of rice-liquor and alum the stone of that province. The most recent editions of works on materia medica contain no reference to the mines in this province, the products of which have surpassed in quality the foreign, and rendered its importation unnecessary. From this and from other circumstances it is certain that the works which we shall now describe have not been long in operation. They are in the Sung-yang hills, bordering on Foh-kien, in the district of Ping-yang, Wan-chau prefecture, and in close proximity to Peh-kwan harbour. (27degs. 9min. 10sec. N., 120degs. 32min. 6sec. E.)

The locality has been visited by one foreigner only, to whom we are indebted for most of the following particulars:—About two months ago he started from Chih-k'i bight, in Lannai harbour, to which Ningpo boats resort for this commodity to the northward of Peh-kwan. Three hours' hard walking over a succession of precipitous hills, crossed by stone steps and pathways, brought him to the mines. Ten alum-making establishments were in operation, which, with the exception of one on a hill opposite, occupied about a mile of the side of a lofty hill. The works were adjacent to the quarries from which the alum-stone seemed to crop out of decomposed rock of the same lithological character. The stones were thrown into a fire of brushwood, where they burnt with a slight lambent flame, and as they cracked the fragments were raked out, broken into small pieces, and macerated in vats. Subsequently the disintegrated mineral was thrown with water into a vessel, having an iron bottom and sides of wood, and boiled for a short time. The lexivium was then poured into large reservoirs, where it crystallised into a solid mass. Blocks of alum, weighing about 50 catties each, were hewn out of the reservoir and carried in this state, in bamboo frames, one on each end of a porter's pole, to the place of shipment, where it is broken into fragments. When not designed for immediate exportation the blocks are stored away for drying. On reaching the depôt the alum is found charged with a double quantity of moisture; the porters being obliged to deliver a certain weight, they slip their burdens in the mountain streams which they pass in the journey. Judging from the number of labourers engaged in transporting the mineral on the day of our informant's visit, the quantity brought from the works could not be less than eighteen tons. This was represented as less than an average day's work, as labour was in such demand just then for agricultural purposes that double pay was gven ; and aged men and women, with boys and girls, were pressed into the service. Assuming that day's product as a basis for calculation, and making an allowance for rainy days, we may safely estimate the annual supply as between five and six thousand tons. The quantity consumed by the dyers of Ningpo prefecture alone, being nearly twenty-two tons per annum, is corroborative of this estimate. The supply is literally inexhaustible. Five dollars-and-a-quarter a ton at the landing would afford the manufacturer a fair profit. It often fetches much more, as there has been an increasing demand for the article, owing to the greater facilities afforded for exportation from Ningpo in foreign vessels.

The Wan-chau alum is equal to the best Roman ;—a roseate tint in some specimens indicates the presence of minute quantities of iron.

We have no means of ascertaining the precise geological position of the rock from which this is alum procured; some circumstances seem to indicate it to be a new mineral. It is stated that no potash nor any other material is employed in the works. Granitic and porphyritic rocks abound in the vicinity, and some parts of the district produce iron and silver. According to the Wan-chau Topography the working of silver was discontinued in the reign of Wan-lih (1615), in consequence of imperial prohibition. This part of the coast has recently become the seat of extensive poppy cultivation, for the bane of the Chinese race.

As a contribution to the physical description of the alum district we would add that the typhoon of September last was preceded by a rising of water in wells and ponds many miles inland. When the cyclone reached the coast it submerged about a hundred square miles, occasioning a vast destruction of life and property. The waters of the sea were retained in the country by strong easterly winds for several days, leaving a strip of land bordering on the sea quite dry.

LISTS OF IRISH SOCIETIES.

It may be a matter of interest to many of the members to know the places in which Scientific and Literary Societies, and kindred Institutions, are situated in Ireland. Moreover, as it is believed that this enumeration is not to be found printed elsewhere, it may possibly, at some time or other, be found useful. Those marked with an asterisk (*) are in union with the Society of Arts, as is also the Dublin Statistical Society itself.

I.—*Corresponding Societies in connection with the Dublin Statistical Society.*

Ardee, Mechanics' Institute.
Armagh, Natural History and Philosophical Society.
Ballynahinch, Literary and Scientific Society.
Banbridge, Literary Institute.
*Belfast, Working Classes Association.
Belfast, Queen's College Literary and Scientific Society.
Belturbet, Literary and Scientific Society.
Carlow, Mechanics' Institute
Coleraine, Mechanics' Institute.
Cork, Cuvierian Society.
Cork, Literary and Scientific Society.
Downpatrick, Mechanics' Institute.
Drogheda, Mechanics' Institute.
Dublin, Mutual Improvement Society.
Dundalk, Mechanics' Institute.
Dungannon, Society for Promoting Literature, Science, and the Arts.
Enniskillen, Literary Society.
*Galway, Royal Institution.
Garvagh, Scientific Society.
Kilkenny, Literary and Scientific Institution.
Killyleagh, Literary Society.
Kilrea, Literary Society.
Limerick, Social Inquiry Society.
Lisburn, Literary Society.
Lurgan, Literary Society.
Mountmellick, Mutual Instruction Society.
Newry, Institute.
*Portaferry, Mechanics' Institute.
Wexford, Mechanics' Institute.

II.—*Societies* not *in connection with the Dublin Statistical Society.*

Belfast, Library Society.
Belfast, Literary Society.
Belfast, Natural History and Philosophical Society.
Belfast, Royal Society for the Promotion and Improvement of the Growth of Flax in Ireland.
*Clonmel, Mechanics' Institute.
*Cork, Royal Institution.
Dublin, College Historical Society.
Dublin, Geological Society.
Dublin, Natural History Society.
Dublin, Royal Dublin Society.
Dublin, Royal Agricultural Improvement Society of Ireland.
Dublin, Royal Irish Academy.
Dublin, Royal Zoological Society of Ireland.
Dublin, University Philosophical Society.
*Dundalk, Literary and Scientific Institution.
Limerick, Institution.
*Limerick, Literary and Scientific Society.
*Waterford, Mechanics' Institution.

Home Correspondence.

FIBRE GILDING.

SIR,—I am happy to be able to endorse the opinion expressed by Mr. Bennoch, in the *Journal of the Society of Arts*, of May 9, relative to the impetus likely to be given to fibre gilding in this country, and the manufacture of articles therefrom, since the commencement of the discussion of the subject in your *Journal*. The number of communications which I have received from firms of the highest respectability in various parts of the United Kingdom, clearly prove that the manufacturers are beginning to appreciate the importance of the matter, and are turning their attention to the means by which the markets of the East may be supplied from this country with articles suited to oriental taste and fashion. Indeed, it is matter of surprise to all persons with whom I have discussed the subject, and who are at all conversant with the matter, how so much apathy could so long have been felt by our usually enterprising manufacturers to a branch of trade the returns of which, as shown by the chairman of the East India Company, are to be reckoned by tens of millions annually.

Mr. Bennoch states, in reply to my former remarks, that in his paper he confined himself to "facts realized," and that he is not aware that any gilded thread, except that exhibited by himself at the rooms of the Society of Arts, had ever been perfected so as to become a "marketable commodity." Now, I need scarcely inform Mr. Bennoch, that it is one thing to realize a fact and another thing to supply the public with such results. The first depends upon the perfectness or simplicity of an invention, or the correctness of a principle; the latter upon pecuniary means or commercial connexions. The history of many of the finest inventions which ever emanated from the genius of man—even those which have tended to elevate Britain in the scale of nations—fully demonstrate this fact. Indeed, it may almost be taken as a rule that the inventor who, by the force of genius, of mechanical or scientific skill, of patient self-denying perseverance and unconquerable energy gives form and beauty to chaos, voice and power to the subtlest elements, who penetrates the earth, and from its teeming bosom brings forth hitherto hidden treasures, and in a thousand ways improves the condition of his fellow man, such a man, I say, is not, as a rule, the one to bring forth the results of his labours commercially before the world.

With regard to the opinion expressed by Mr. Bennoch that I wish to plume myself on the presumed fact of priority of invention, I would simply remark that such is not the case. My former remarks applied to this country, and I neither need nor desire to rest my claim to priority of invention upon any *presumption*, nor to plume myself with false claims.

As respects the relative qualities of the productions of Mr. Hock and myself, nothing could give me greater pleasure than to accept the challenge of Mr. Bennoch, and prove that my plan *is* superior to that of Mr. Hock, both as regards cost and facility of production, as also in brilliancy of effect. By Mr. Bennoch's own showing he is not able to produce a thread sufficiently bright to meet the requirements of existing tastes and fashion, but merely "a new and very expensive colour," whereas I am enabled to gild threads of any length, on either side, at *one operation*, and, at the same time, produce the highest degree of brilliancy of which gold or metal leaf is susceptible, such brilliancy being attained by means of highly polished steel rollers, as specially specified in my patent.

I cannot, however, but express my thanks to Mr. Bennoch for his disinterested attempts to arouse the manufacturers of Britain from their lethargy, and I hope and believe the time is not distant when the manufacture of Pugrees, Sarhees, Dupottas, and other articles suited to the Eastern markets, will become a staple trade of this country. With regard to the tinselled appearance now considered so necessary, I would observe that nothing is so capricious and evanescent as fashion. A frown or a smile from royalty may change it in a day, and I doubt not but a little energy and perseverance on the part of a few manufacturers of eminence, and the production of a new class of chaste designs, would wean the people of India from their present love of glitter, and create, in lieu thereof, a taste for the beautiful for its innate worth, while, at the same time, it would tend to awaken a greater taste for this class of articles in our own land.

I have, &c.,

WILLIAM GREEN.

57, York-street, City-road, London, May 12, 1856.

TONNAGE REGISTRATION.

Woolwich Dockyard, May 8, 1856.

SIR,—The following advertisement having been published in the *Times* newspaper:—

"THE TONNAGE OF SHIPS.—For a comprehensive article on this subject, see the last four numbers of the *Mechanics' Magazine*, Nos. 1,705-6-7-8," and finding that the article referred to is a running criticism on the paper on "Tonnage Registration" read by me at the Society of Arts on the 16th of January last, and the discussions and correspondence thereon which have been published in the *Journal of the Society of Arts*, I beg the favour of your inserting, in your *Journal* for this week, the annexed letter which I have addressed to the Editor of the *Mechanics' Magazine*, intimating that I purpose, when the article referred to shall be complete, to respond as respects a few points on which my acknowledgments are due to the author thereof.

I am, Sir, your obedient servant,

CHARLES ATHERTON.

To the Editor of the Mechanics' Magazine.

Woolwich Dockyard, 6th May, 1856.

SIR,—Referring to the "Note on Tonnage Registration" in No. 1,708 of the *Mechanics' Magazine*, page 420, correcting the typographical errors that unfortunately pervaded the exposition given in No. 1,707 of Stirling's Formula for calculating the cubical contents of an irregular solid, or space, by means of rectangular co-ordinates referred to the circumscribing parallelopipedon, being an exposition of the rationale of the rule for tonnage admeasurement under the Merchant Shipping Act of 1854, your correspondent, on looking further into this matter, will doubtless observe that the list of typographical corrections, as given in No. 1,708, page 420, are still far from completely correcting the typographical errors of the formula referred to, as enunciated in No. 1,707, page 392, and as a second edition of such typographical corrections would be inconvenient, your readers, who may be giving attention to this subject, would probably be obliged by your reprinting the whole formula, duly revised and corrected, to facilitate their perusal thereof. I may further submit for your consideration that, by your introducing textually the rule for calculating tonnage, as deduced from the formula referred to, and prescribed by the Merchant Shipping Act of 1854, you would still more satisfactorily elucidate this matter. Permit me further to suggest, for your correspondent's consideration, whether in the text, explanatory of "what is meant by the curve of sections," there are not some further errors, either typographical or textual, not clearly expressing the intended sense of the text. I also beg to intimate that, when your article on the Merchant Shipping Registration Act, in exposition of my paper thereon, read before the Society of Arts on the 16th January, 1856, shall be completed, as I presume it will be on the correction of the typographical errors, I may probably request the favour of your inserting a few remarks from myself, referring to various points of your criticism on my paper, on which my acknowledgments are due to your anonymous correspondent, or per-

haps to yourself, as the editor of the *Mechanics' Magazine*, and possibly the author of the article referred to.

I am, Sir,
Your very obedient servant,
CHARLES ATHERTON.

DECIMAL SYSTEM—WEIGHT OF COINS.

SIR,—Whatever system of decimal coinage, if any, be resolved on by the Government, it would perhaps be advisable to regulate the weight of new coins according to the French metrical system. Thus a sovereign might be made, by alloy or otherwise, to weigh 8 *grammes*, instead as of as at present 7.983 *grammes* (= 123.274 grains). Also the silver coinage might be rated at 16s. 8d. the 100 *grammes*, and the copper at 50 pence the *kilogramme*. The *gramme* would accordingly become the element of a new weight, which might be termed, for distinction, "money weight," by which all commodities for Government use, at least, should be purchased. This would quickly prepare the way for an international system.

Your obedient servant,
S. A. GOOD.

H.M. Dockyard, Pembroke Dock,
May 13, 1856.

Proceedings of Institutions.

BARNET.—The season at the Institute was brought to a close on Wednesday, April 30th, 1856, with a musical and literary *soiree*, which attracted an unusually large attendance. A very tolerable collection of works of art, consisting of sculpture, painting, a model of Barnet church, some Indian and African curiosities, old coins (including some specimens of *coal* money), were exhibited, kindly lent for the occasion by Mr. Thimbleby, Capt. Bowie, Sergt. Taylor, Mr. Greenhill, and other friends. The musical performance included the overtures to *Semiramide* and *La Nozzi*. In the hall there was a brilliant display of exotic plants, supplied from the establishment of Mr. William Cutbush. In the course of the evening, the meeting was addressed by Mr. W. Sumpster, Mr. Burch, and the president, Mr. Thimbleby. Votes of thanks were afterwards passed to those who had lent articles for exhibition, or had assisted in the musical performance. During the past season the following lectures have been delivered:—"Why am I?" and "The Lake Poets," by Mr. E. W. Cox; "The Chemistry of War," by Mr. T. A. Smith; "Old Sailors," by Mr. Henderson; "Scraps," by Mr. Hyam; "A Ten Days' Visit to France," "Ennobled Characters," Mysteries of Money," "A Reading from Macaulay's History of England," by Mr. Thimbleby; "English Music and English Musicians," by Miss B. Williams and Messrs. Williams; "The Beauties of Nature," "Life and Times of Mary, Queen of Scots," by Mr. Sumpster; "Nineveh," "The Deluge," by Mr. D. Burnett; Concert, by the Band of the Middlesex Rifles; "Poland," by Mr. W. Wyke Smith (two); "Atmospheric Air," "A Night with Samuel Lover," by Mr. Homerton (who also read Mr. Wilson's paper, delivered at the Society of Arts, "On the Manufactures of Price's Patent Candle Company"); "Monastic Institutions," by Mr. Wilbraham Taylor; "Poetry," by Mr. W. Baldock, sen. (two); "Electricity," by Mr. H. Thimbleby; "Curiosities of Animal Life," Mr. Burch.

BRIGHTON.—The Fifth Annual Report of the Mechanics' Institute congratulates the members upon the present prosperous state of the Institution, the number of its members having more than doubled during the year. At the commencement of the year, there were only 392 *bona fide* members; whereas now there are 871, nearly 200 of whom are females. The funds are in a most flourishing condition, and the enforcement of fines for non-return of books borrowed from the library has been an additional source of revenue to the Institution. The Fête and Soirée have been another source of revenue. The Report then refers to the good feeling existing between the different Institutions in the town, which the Committee trust may long continue. The library, it is stated, now contains 3,057 works of a standard and readable character. The increase of books during the past year has amounted to 361 volumes, 114 by purchase, the remaining 247 by donations, including a donation of fifty-six readable volumes from the oldest Vice-President, Cordy Burrows, Esq. Though works of fiction are in the greatest demand, the Committee state that books of a superior character are read in a much higher proportion than in many other Institutions. The Reading Room has been well attended during the year, and the entertainments given in it by the Mechanics' Institution Band, the Brighton Vocal Union, and the Elocution Class, gave general satisfaction. The classes of the Institution have this year put forth more intellectual strength than they have before assumed. These include the elocution class, conducted by the Rev. A. J. Ross, to which Lady Noel Byron has given a donation of £5, to be awarded in books as prizes to four of its members, who, upon examination, were considered the most proficient. Lady Noel Byron also placed a room at the disposal of Mr. Ross for the use of the class. There is likewise a discussion class; and a class on the "Study of the Human Frame," conducted by Dr. King. The classes on English Grammar, the Rudiments of Latin, Arithmetic, and Writing, conducted by J. Andrews, and T. W. Wonfor, Esqrs., and Mr. Austin, have latterly fallen off. The Committee express regret at the breaking up of the Mechanics' Institution Band. They then refer to the certificates of ability to be granted by the Society of Arts. During the past year twenty-eight lectures and musical entertainments were provided, fourteen of which were delivered gratuitously, including a Reading of Shakspeare's "King Henry V.," by Mrs. Fanny Kemble, to whom the thanks of the Institution were considered as being specially due, as also to Dr. Latham, Professor Creasy, the Rev. J. Griffith, M.A., Rev. A. J. Ross, Lieut.-Colonel Fawcett, Barclay Phillips, Kerrison Sala, F. Merrifield, Cordy Burrows, Montague L. Phillips, T. W. Wonfor, M. Penley, and P. O'Brien, Esqrs., Herr Kuhe; Mr. Kirchner, Messrs. Gates, Zirom, Jewell, W. and R. Devin, and Affleck; the Pavilion, Militia, and Railway Bands; and to the Misses Brougham, for their gratuitous services at the Soirée. From the Treasurer's Report, it appears that the receipts during the year amounted to £326 15s. 8½d., the expenditure to £292 8s. 5½d., leaving a balance in hand of £34 7s. 3d.

HASTINGS.—The quarterly meeting of the members of the Mechanics' Institution was held on Wednesday evening, May 7th, Mr. W. Ransom in the chair. The Secretary (Mr. Banks) read the report, from which it appears that at this period last year, the number of members was 374; during the year, 130 have joined the Institution, 150 have left, so that the number now stands 354. During the quarter just closed, 11 have been elected, and 28 have left. Considerable additions have been made to the library, but not to the extent the committee could wish. The following lectures were delivered during the session:—Mr. Wheeler, "Philosophy of Heat and Cold;" Mr. John Banks, "Nitrogen Gas, and the Non-Metallic Elements;" Mr. C. J. Womersley, "Literary History of the Bible, and the Plurality of Worlds;" Mr. Elliott, "Music;" Mr. Caviler, "The Alhambra;" Mr. Hidolph, "The Connexion between the Animal and Vegetable Kingdoms;" Rev. Mr. Stewart, "Fifty Years Ago;" Dr. Turner, "The Philosophy of the Eye;" Mr. A. Ransom, "Chaucer and his Times;" Mr. James Rock, jun., "Carriages;" T. P. Langham, Esq., "On Sound" (two lectures); T. H. Cole, Esq., M.A., "Sardinia;" J. G. Dodson, Esq., "The Ottoman Empire;" Mrs. Balfour, "The Seasons and their Relations;" F. North, Esq.,

M.P., "The Wars of History, and their Effects upon Society;" Mr. W. R. Selway, "Insects in Relation to Man;" Mr. J. Bennett, "A Watch: how to make it, &c.;" Mr. Butler, "Pneumatics;" Mr. Pitter, "Aerial Locomotion." The lectures were all gratuitous, except Mr. Wheeler's and Mrs. Balfour's. Three were given on the payment of the expenses of the lecturer, so that 17 were without any expense to the Institution beyond the hire of the room. The sum of £10 13s. has been taken for the admission of non-members to the lectures. With reference to the Society of Arts examination, a sub-committee has been appointed, whose especial duty it will be to regulate the class department, so as best to secure the proper and efficient working thereof. The Treasurer's account showed receipts for subscriptions from members during the year, £134 5s. 6d.; lectures, £10 13s.; sundries, £5 9s. 11d. Payment for newspapers, £23 12s. 4d.; books and periodicals, £19 3s. 10d.; for lectures, £46 2s. 8d.; rent, £18; librarian, £22 13s. 3d.; gas for two years, £20 9s.; collector, £6 17s.; printing and sundries, £25 10s. 3d.; and a balance in hand of £9 15s. 11d. This being the annual meeting, as well as a quarterly one, the election of officers took place. The result was as follows:—*President*—G. Scrivens, Esq., re-elected; *Vice-Presidents*—F. North, Esq., M.P., Rev. J. Stent, and Messrs. Womersley, Chamberlin, Rock, and W. Ransom, re-elected; *Treasurer*—Mr. J. Hallaway, re-elected; *Secretary*—Mr. J. Banks, re-elected; *Committee*—Messrs. C. Goddard, T. H. Cole, T. S. Hide, J. Purfield, T. Edwards, William Hallaway, William Harman, Ashby, C. Duke, jun., and J. H. Braye. Mr. Banks then read a report from the Museum Committee, in which several donations of money and specimens in natural history were acknowledged. Thanks were then given to the lecturers of the session just over, and to the officers of the past year.

LYNN.—The annual general meeting of the Conversazione and Society of Arts, was held in the lecture-room of the Athenæum on Friday evening, the 25th of April. During the last session the Society has been unusually active in its operations, but these efforts have not been appreciated by those whose advantage it was desired especially to promote. The average attendance at the fortnightly meetings has not been so large as the voluntary efforts of the lecturers deserved. By the financial statement it appeared that a considerable outlay had been made above the income, but not to such an extent as to affect materially the operations of the Society during the next session. If the number of members be slightly increased, the balance-sheet of next year will, it is hoped, show a very different position. The following gentlemen were elected as the officers of the Society for the next session:—Mr. H. Wells, president; Lord Stanley and Mr. H. Edwards, representatives to the London Society of Arts; Mr. H. Edwards and Mr. J. G. Wigg, representatives in the Athenæum council; Mr. Robinson Cruso, treasurer; Revs. T. B. Scott, A. McDonald; Messrs. W. Taylor, J. W. Aitkin, F. Kendle, R. Cruso, jun., W. B. Whall, P. Wilson, W. M. Lupton, W. Cooper, J. G. Wigg, and D. C. Burlingham, the committee; Mr. E. L. King, honorary secretary.

MORPETH.—The exhibition of works of art, and of other objects of interest, in connection with the Mechanics' Institution, which was opened on the 24th of March, has been brought to a conclusion. It is believed that when the accounts are closed, there will be a balance of £12 or £14 in favour of the Institution. The desire of the public to view the articles displayed in the rooms, and to be present at the lectures that were delivered, appeared to increase from the first. The number of members present on the Wednesday evenings, on which concerts were given, was great beyond precedent, and many had to go away, unable to procure admission. Lectures were given by Geo. Brumell, Esq., the Hon. and Rev. F. R. Grey, E. W. Challoner, Esq., the Rev. R. T. Rundle, the Rev. Wm. Ayre, the Rev. S. B. Maughan, the Rev. Henry Hopwood, the Rev. E. J. Maskery, the Rev. J. C. Norman, the Rev. C. T. Whitley, the Rev. James Anderson, and Dr. Donkin. The concerts were given by the Morpeth Philharmonic Band, conducted by Mr. Whinham, and by the choir of St. James's church, led by Mr. John Bates, assisted by a portion of the choir of St. Robert's. The committee of management have much reason to be satisfied with the result of their labours, and great cause to be grateful to many families in the town, and to the gentry of the surrounding district, for the ready and generous manner in which they came forward in contributing interesting objects for the use of the exhibition.

NEWPORT (Monmouthshire).—The fifteenth annual report of the Athenæum and Mechanics' Institute commences by stating that the liabilities at the commencement of last year amounted to £96 2s. 2d. As it was considered that the ordinary receipts of the Institute would never be sufficient to remove this debt, it was thought desirable to make a special effort for the purpose. Accordingly, a public *soirée* was held with very satisfactory results. Tea was provided on the occasion, and during the evening addresses were given on behalf of the interests of the Society, interspersed with vocal and instrumental music. Trays were given, or an equivalent in money, amounting to £15, and during the evening a subscription was set on foot, and about £54 was promised, nearly all of which has been collected, making, with the proceeds from the *soirée*, a sum of £65. The proposed new building has been abandoned, as not more than ten subscriptions have been promised. There have been added (with bound periodicals) 34 volumes to the library, which now contains 2,171 volumes. The number of books circulated during the past year has been 8,685. The lectures delivered during the session were:—"Some Passages of Russian History," by Mr. G. Dawson; "The Life and Writings of Thomas Campbell," by Mr. J. Harrison; "An Illustrative and Impersonal Entertainment, in two parts," by Mr. W. Rowton; "On Character," by Mr. Christophers; "The Combination of the Sublime and Ridiculous," by Mr. A. Bunn; "The Lake Poets," by the Rev. W. Aitcheson; "Martin Chuzzlewit," by Mr. G. Grossmith; "On Self-culture," by Sir Thos. Phillips. The expenditure during the year amounted to £241 2s. 10d; the receipts to £241 6s. 5½d.; leaving a balance in hand of 3s. 7½d.

PLYMOUTH.—At a meeting of the members of the Institution, on the 6th March last, Mr. J. N. Hearder, mechanician, of Plymouth, delivered a lecture "On the Induction Coil," illustrated by one of his own construction. The lecturer commenced by an explanation of some of the elementary phenomena involved in the action of the apparatus, and elucidated by experiment the discoveries of Oersted, Sturgeon, Faraday, and others, so far as they showed the gradual development of the science of electro-magnetism. The lecturer stated, that having been engaged for many years in the construction of magneto-electric machines, he had often been struck with the power obtained in the secondary coil, though there were no pretensions to insulation in it, beyond the ordinary inferior conducting character of cotton and mahogany. And remarking that even under these disadvantages he frequently obtained continuous streams of static sparks from the secondary terminals, he had often promised himself to construct an apparatus with a perfectly insulated secondary coil, but want of leisure prevented him from carrying out his intention. As soon, however, as he heard of the effects produced by Ruhmkorff's coil, without waiting for a description of it, he proceeded to construct one on his own plan, and with what success the Society would judge for themselves. Since his instrument was constructed, he had had an opportunity of witnessing the effects of one of Ruhmkorff's machines, and it was gratifying to him to discover that his first attempt had, he believed, surpassed what had been achieved on the continent. The instrument before the Society was about half the size of Ruhmkorff's, and, from what he could learn,

contained only one-third the quantity of secondary wire. Several of his arrangements differed from those of Ruhmkorff's, but the machine, although smaller, was more powerful. The lecturer then excited the machine with ten Maynooth cells, and exhibited the usual experiments of burning paper, wire, turpentine, and other inflammable substances. The spark between the terminals was more than 0.6 of an inch in length, and was not shortened when a Leyden jar containing two square feet of surface was interposed, which discharged, with thick dense sparks, at the rate of 300 to 400 discharges per second. On passing this current with an iron chain 30 feet long, it appeared like an immense garland of fire, the lateral scintillations from the links being nearly six inches in length, thus making the chain appear as if it were in a state of vivid combustion, ready to fuse and fall upon the floor of the hall. On passing the discharge through a very large lump of sugar, the light was so vivid that the apparatus on the table was illuminated by it. Straight, dense, red sparks, of nearly two feet in length, were produced in an exhausted receiver, and Gassiot's cascade over the edge of a large glass vase streamed out with great brilliancy. After stating his views with regard to the action of the condenser, which in his instrument was rather peculiarly constructed, and could be readily detached from the coil, he described some arrangements for comparing the induction coil with the ordinary electrical machine, and concluded by stating his belief, that secondary currents had very little to do with primary ones, but were the result of the middle agent, viz., the magnetism. In the construction of his instrument, he had been guided by the conviction that the secondary current depended upon the magnetic intensity of the iron core, no matter how that intensity was produced, and he believed that his success had resulted from his having kept that principle in view.

ROYSTON.—On Whit-Monday, an exhibition, in aid of the building fund, was opened in the new hall of the Institute. Nearly a thousand articles are enumerated in the catalogue, and these include a great number of exceedingly rare and beautiful samples of natural and artificial productions. The Fine Arts are well represented by pre-Raphaelite pictures, contributed by Mr. Ruskins—by some fine paintings, pieces of Scripture, and bronzes, from the Earl of Hardwicke's collection—and many other examples in oil and water colours, including a very interesting sketch by H. C. Brown. There are also a fine collection of photographs, chromo-lithographs, and nature-prints, antiquities—oriental manuscripts and manufactures—collections of porcelain—and numerous other examples of the efforts of human industry, which give a most instructive character to this exhibition. On Tuesday evening, Robert Hunt, Esq., F.R.S., lectured on the exhibition, During the lecture he described Paul Pretsch's new process of Photogalvanography, and exhibited some of the most recent and perfect of the prints produced at his establishment. The proceeds already amount to nearly £100. Efforts are being made to form a museum of local productions. Chalk fossils, the flora of Royston Heath, and antiquities found near Royston, are already collected.

PARLIAMENTARY REPORTS.

SESSIONAL PRINTED PAPERS.

Delivered on 7th May, 1856.

Par. No.

164. Prisons, &c., Schools—Abstract of Return.
102. Bills—Reformatory and Industrial Schools (amended).
123. Bills—Drainage (Ireland).
124. Bills—Fire Insurances (amended).
125. Bills—Justices of the Peace Qualification (amended).
127. Bills—Industrial and Provident Societies.
128. Bills—Transfer of Works (Ireland).
129. Bills—Pawnbrokers.

Public General Acts—Cap. 17, 18, and 19.

Delivered on 8th May, 1856.

159. Election Auditors—Return.
197. Navy Estimates, &c. (Original and Revised Amounts)—Statement.

The Netherlands—Convention.

Delivered on 9th May, 1856.

186. Rural Police—Return.
190. Silver and Gold Wares—Report from the Committee.

To Correspondents.

ERRATA.—In last number, page 413, in list of members elected, for "Niblet," read "Niblett;" and page 420, col. 2, line 12, for "it was stated," read "he stated;" and lines 17 and 18, for "Professor Hosk*yns*, the official referee of the insurance companies," read "Professor Hosk*ing*, the official referee."

MEETINGS FOR THE ENSUING WEEK.

MON. Architects, 8, Mr. John Clayton, "On the Bridges and Viaducts of the Present Day."
Chemical, 8, 1, Messrs. Goessman and Atkinson, "On Lophine;" 2, Mr. J. A. Wanklyn, "On Cadmium-Ethyl."
Statistical, 8, 1, Mr. F. Hendriks, "On the Loss sustained by Government in granting Annuities;" 2, Dr. Samuel Fenwick, "On the Effects of Overcrowding and Want of Ventilation on Cholera."

TUES. Pharmaceutical, 12 noon, Anniversary.
Royal Inst., 3, Mr. T. A. Malone, "On Photography."
Civil Engineers, 8.
Pathological, 8.

WED. London Inst., 3, Professor Rymer Jones, "On Entomology, and the General Organisation and Metamorphoses of Insects."
Society of Arts, 8, Mr. T. Winkworth, "On the British Silk Manufacture, its Condition and Prospects, as compared with that of other Countries."
Geological, 8, Mr. Charles Babbage, "On the Influence of Ocean Currents on the Formation of Strata."

THURS. Royal Inst., 3, Prof. Tyndall, "On Light."
Antiquaries, 8.
Royal, 8½.

FRI. Philological, 8, Anniversary.
Royal Inst., 8½, Mr. F. A. Abel, "On some of the Applications of Chemistry to Military Purposes."

SAT. Linnæan, 1, Anniversary.
Royal Inst., 3, "Dr. A. W. Hofmann," On the Non-Metallic Elements, their Manufacture and Application."
Royal Botanic, 3¾.
Medical, 8.

PATENT LAW AMENDMENT ACT, 1852.

APPLICATIONS FOR PATENTS AND PROTECTION ALLOWED.

[*From Gazette May 9th*, 1856.]

Dated 17th January, 1856.

131. John Platt and John Whitaker, Oldham—Improvements in machinery or apparatus for doubling or twining yarns or threads, parts of which improvements are also applicable to mules for spinning.

Dated 15th April, 1856.

895. Hugo Frederick Forbes, Park-place, Regent's-park—Improvements in breech-loading fire-arms and ordnance, and in projectiles used therewith.
897. William Smith, Aston, near Birmingham—Improvements in the manufacture of steel wire for musical and other purposes.
899. Edmund Richard Southby, Bulford, Amesbury, Wilts—Improvement in coating iron with copper.
901. Joseph Demain, Markington, York—Improvement in connecting railway carriages.

Dated 16th April, 1856.

903. William Routledge, Salford—Improvements in the construction of steam engine and other boilers to prevent explosions.
905. Frederick Priestley, Cleveland-street, Fitzroy-square—Improvements in piano-fortes.
907. Thomas Mellodew and John Duxbury, Oldham—Improvements in shuttles for weaving.
909. William Edward Newton, 66, Chancery-lane—Improved apparatus for raising sunken vessels and increasing the buoyancy of floating vessels. (A communication.)
911. William Armitage and Henry Lea, Farnley Iron Works, near Leeds—Improvement in the manufacture of iron.
913. William Wilkinson, Hull—Improvements in steam-engines.

Dated 17th April, 1856.

915. Henry Young Darracott Scott, Capt., R.E., Brompton Barracks, Chatham—Improved mode of manufacturing cement.
917. Lianna Mesure, Billericay, Essex—Improvement in watches.
919. John Luntley, Broad-street—A new fabric or new fabrics suitable for wearing apparel and other purposes to which textile fabrics are applicable.

Dated 18th April, 1856.

921. George Lurig, Adelebsen, Hanover—Improvements in the process of manufacturing saltpetre.

923. William Tytherleigh, Birmingham—Improved method of coating or covering iron or articles of iron with copper or alloys of copper.
925. William Budden, Ipswich—Improved method of preparing cheques, invoices, and other papers, so that they may be readily separated from their counterparts.
927. Thomas Hollingworth, Turkey Mill, near Maidstone—Improved machinery for dusting or cleaning rags.
929. Edward Vincent Gardner, 24, Norfolk-street, Middlesex Hospital—Improvements in furnaces.
931. George Thompson, Marchmont-street, Russell-square—Improvements in instruments or apparatus used in drawing or marking with crayon, "black-lead," or other such materials.
933. Peter William Barlow, Great George-street, Westminster—Improvement in seasoning timber.

Dated 19th April, 1856.

935. Claude Moret, 39, Rue de l'Echiquier, Paris—Improvements in rotary steam engines.
937. Thomas Blackburn, Brighouse—Improvements in preparing for spinning cotton waste and silk waste.
939. Charles Frederick Stansbury, 67, Gracechurch-street—A new instrument for determining the position and bearing of ships at sea. (A communication.)
941. Thomas Wilkes, Birmingham—Improved method of manufacturing tubes of copper and alloys of copper.
943. Robert Hazard, 1, Thanett-place, Strand—A heat extractor for extracting the heat from the smoke or heated gases in its passage from boilers, stoves, or furnaces to the chimney, and rendering the economized heat available for drying and warming purposes.

Dated 21st April, 1856.

947. Patrick Heyns, Poplar—Improvements in railway wheels.
949. Samuel Mellor, Salford, and Thomas Young, Manchester—Improvements in machinery for supplying water to steam boilers.
951. William Owen, Lincoln's-inn-fields—Improvements in the modes of attaching buttons to wearing apparel.
953. William Maugham, Ifield-terrace, Stockwell—Improvement in the preparation or manufacture of starch.

Dated 22nd April, 1856.

955. William James Cantelo, Southwark—Improvements in the preservation of vegetable matters.
957. Alexander Symons, George-street, Mansion-house, and Edward Burgess, Clerkenwell-green—Improvements in instruments for ascertaining and indicating heat, and also in the parts for making and breaking contact in electric circuits used therewith.
959. Augustin Simeon Vimont, Vire (Calvados) France—A new system of machine for spinning wool and any other fibrous material.
961. Peter Brown and George Brown, Liverpool—Improved apparatus applicable to furnaces, fire-grates, fire-places, or stoves, for the purpose of economizing fuel and heat.
963. Christopher Nickels, Albany-road, Camberwell, and James Hobson, Leicester—Improvement in machinery for weaving carpets and terry fabrics.
965. Thomas Jeacock, 20, Bridge-street, Leicester—Improvement in knitting machinery.
967. William George Armstrong, Newcastle-upon-Tyne—Improvements in apparatus for lifting, lowering, and hauling.

Dated 23rd April, 1856.

971. Adam Bullough, Blackburn—Improvements in looms.
973. William Peacock Savage, Roxham—A machine for drilling and rolling land.
975. John Shae Perring, Radcliffe—Improvements in chairs for railways.
977. James Barbour, Glasgow—Improvements in sawing apparatus.
979. David Brown, Smethwick—Improved method of joining the rails of railways.

Dated 24th April, 1856.

981. Abel Désiré Schratz, Saint Denis, near Paris—Improvements in preparing colours for the impression of woven or textile fabrics or stuffs of any kind.
982. John Yeomanson and William Yeomanson, Leicester—Improvements in the manufacture of knitted fabrics.
983. Thomas Woodcock and John Killingworth Punshon, 26, Great Ormond-street—A machine for cutting and slicing bread and other substances.
984. George Ashworth, Sunny Bank Mills, Rochdale—Improvements in machinery for preparing slivers or slubbings of wool and other fibrous materials, commonly called condensing carding engines.
985. Charles Cowper, 20, Southampton-buildings, Chancery-lane—A new yarn or thread, and its application in the manufacture of stockings, gloves, and looped and other fabrics. (A communication.)
986. Fennell Allman and Donald Bethune, Cambridge-terrace Hyde-park—Improvements in apparatus for the production of steam, and in the apparatus employed in its application to motive purposes.
987. Victor Doat, Albi, France—Improved galvanic battery and method of recovering and revivifying the agents employed.
988. Walter Neilson, Glasgow—Improvements in locomotive engines.
989. Frank William Blacket, West Smithfield—Improvement in the construction of keys and locks, and in the fitting of locks, to afford increased safety.
990. Thomas Moore, Retford—Improvements in machinery for riddling and winnowing or cleaning corn and other grain.

Dated 25th April, 1856.

991. William Naar, Glasgow—Improvements in folding or adjustable articles of furniture.
993. John Hardacre, Manchester—Improvements in the arrangement and construction of carriages and carriage wheels.
994. Charles Swift and John James Derham, Blackburn—Improvements in steam engines.
995. Isaee Daniel Fraëtaniel, Paris—Improved safety rein or bridle.
996. William Gossage, Widness, Lancaster—Improvements in the manufacture of sulphuric acid.

Dated 26th April, 1856.

998. Thomas Hill, Heywood, Lancaster—Improvements in steam boilers and furnaces connected therewith.
1000. Edmund Topham, Mansfield-road, Nottingham—Apparatus for cleansing out the sediment from the water in steam boilers and preventing incrustation of the same.
1002. William Edward Newton, 66, Chancery-lane—Improved machinery for manufacturing painted or enamelled cloth. (A communication.)
1004. Thomas Walker, Warwick-place, Pimlico—Improvements in playing cards.
1006. Thomas Heiffor, Sheffield—Improved method of manufacturing razor blades.

Dated 28th April, 1856.

1008. Jean Charles Bertrand Dubos, Paris—Improved electro-magnetic apparatus.
1010. Henry Geering, Birmingham—Improvements in metallic bedsteads, chairs, couches, and other articles for sitting, lying, or reclining upon.

Dated 29th April, 1856.

1012. Charles Joseph Graftiaux, Molenbeck St. Jean by Brussels—Improvements in rotary steam engines.
1014. James Stead Crosland, Openshaw, near Manchester—Improvements in furnaces and steam generators for locomotive steam engines and other purposes.
1016. Charles Titterton, Roehampton—Improvement in the manufacture of white zinc.
1018. Isaac Abraham Boss, Bury-street, City—Improvements in preparing cane, in order to render it suitable to be used as a substitute for whalebone. (A communication.)
1020. John Henry Johnson, 47, Lincoln's-inn-fields—Improvements in anchors. (A communication.)

Dated 30th April, 1856.

1022. Francis Gybbon Spilsbury, Chaudfontaine, Belgium, and 56, Stones-end, Borough—Separating metals, metallic oxides, and metallic acids from their ores.
1024. Joseph Rigby, Ashton-under-Lyne—Improvements in machinery for grinding or sharpening the card cylinders and rollers of carding engines.
1026. Wright Jones, Pendleton—Improvements in apparatus for regulating the pressure and flow of steam, water, and other purposes.

WEEKLY LIST OF PATENTS SEALED.

Sealed May 9th, 1856.

2551. Fischer Alexander Wilson.
2560. Henry Laxton.
2561. James Burrows.
2575. Franz Duncker.

PATENTS ON WHICH THE THIRD YEAR'S STAMP DUTY HAS BEEN PAID.

May 6th.

1135. John Fisher.
1157. Samuel Cunliffe Lister.

May 7th.

1232. William Gossage.
1287. William Haslett Mitchel.

May 8th.

1136. David Law.
1140. Thomas Quaife.
1144. Thomas Murray.
1190. George FitzJames Russell.

May 9th.

1143. John Clapham, Thomas Clapham, and William Clapham.
1194. Thomas Stephen Holt.
1196. Herman Dirs Mertens.

May 10th.

1167. Edmund Whitaker and James Walmsley, jun.
1175. Joseph Denton.
1203. John Drumgoole Brady.
1204. Robert Walter Swinburne.

WEEKLY LIST OF DESIGNS FOR ARTICLES OF UTILITY REGISTERED.

No. in the Register.	Date of Registration.	Title.	Proprietors' Name.	Address.
3835	May 8.	Brass-bound Square or Bevel	Silverwood and Marsh	Sheffield.
3836	May 9.	E. Wood's Ever-Pointed Receding Pencil.	Ebenezer Wood	6, Felix-street, Liverpool-road, Islington.